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An investigation into risk management practices in construction projects: the case of United Arab Emirates.

Al Hasani, Mundhir Mahmood Abdullah

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An Investigation into Risk Management Practices in Construction Projects: The case of United Arab Emirates

Mundhir Mahmood Abdullah AL-Hasani

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“Four things support the world: the learning of the wise, the justice of the great, the prayers of the good, and the valour of the brave.”

Muhammad a.s.

“No construction project is risk free. Risk can be managed, minimized, shared, transferred, or accepted. It cannot be ignored.”

Sir Michael Latham, 1994

Abstract

The Middle East is one of the world's most important regions located strategically at the crossroads of major transportation and communications routes and endowed with the world's largest oil reserves, both of which are important factors for the stability of the global economy. Construction is a major industry in emerging economic development, particularly in developing countries. The United Arab Emirates (UAE) has the second-largest economy in the Middle East and has experienced an unprecedented construction boom in the past four decades. The country has unique economic and cultural characteristics related to the exceptionally diverse cultural and ethnic mix of its workforce and the high proportion of multinational companies and investors in the construction market. Construction projects have grown rapidly in complexity and size, thereby creating a variety of cultural and economic risks that must be identified and managed by construction companies. Major stumbling blocks to improved performance in construction and broader economic development in the UAE include difficulty identifying and characterising risks, limited evaluation of the effects of risks on project success and an insufficient understanding of methods that can be implemented to improve risk management practices.

This thesis presents quantitative and qualitative analyses of the risks and risk factors in the UAE construction industry and risk management practices and scope for their improvement. It also contains practical recommendations to achieve greater success in construction projects. Results were obtained from a questionnaire survey of 237 responses and 13 interviewees. The analytical methodology is largely based on a survey instrument for the collection of risk-related data in the UAE construction industry. Advanced statistical methods used to analyse the data include exploratory and confirmatory factor analyses (to identify and characterise major risk factors); generalised structural equation modelling to evaluate networks of direct and indirect effects of the measured variables (including demographic and company variables); risk factors on project success; and risk management practice outcomes. There is a special focus on cultural and economic risks. Five models are developed and cross-compared to identify the following major risk factors: external risks (e.g., government, economic, legal and cultural frameworks); communication (within companies and between project stakeholders); cultural diversity (in the UAE workforce); and resources and technology importance (e.g., availability of materials, human resources and modern technologies). Except for the tighter focus on time and diversity of educational backgrounds in the workforce, most cultural risks have significant negative effects on project success in the UAE context. Major strategies for improving risk management in the UAE construction industry include formally implementing risk assessment; employing dedicated risk assessment experts; taking calculated risks (instead of total risk aversion); managing diverse decision-making processes and languages; introducing effective dispute-resolution procedures; and improving communication between contractors, clients and consultants.

The outcomes and findings of this research significantly expand the use of quantitative approaches in risk management research and constitute a step towards the better identification, understanding and characterisation of construction risks. The additional qualitative analysis of the interview data further validates the quantitative outcomes, evaluates their completeness and identifies possible improvements to risk management practices in the UAE. The outcomes and recommendations are likely to contribute to the improvement of current risk management practices in the UAE construction industry and to improve efficiency and rate of success of current and future construction projects.

Finally, this study contributes to current general knowledge of risk management research. Its findings and outcomes are also expected to assist with developing practical and useful guidelines for risk management in the specific context of the UAE construction industry and other countries with a similar situation.

Keywords

United Arab Emirates; project management; risk; risk management practices; construction projects; project success; construction risks; economic risks; cultural risks.

Declaration

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Doctor of Philosophy. This thesis represents my own original work towards this research degree and contains no material that has previously been submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

11 April 2018
Date

Mundhir AL-Hasani

Publications During Candidature

The following papers have been published in refereed journals and conferences during the three years that the research was conducted.

Book Chapter

Al Hasani, M., & Regan, M. (forthcoming). Managing risk in the construction industry: The case of United Arab Emirates. London: Routledge.

Journal Publications

Al Hasani, M., & Regan, M. (2017). Understanding risk and uncertainty management practice in complex projects. *European Journal of Economics, Law and Politics, ELP*,*4*(4), 24-38.

Al Hasani, M. (2018). Understanding risk and uncertainty in project management. *European Journal of Economics, Law and Politics, ELP*,*5*(1), 30-40.

Al Hasani, M. (2018). Cultural and economic risks factors in UAE construction projects. International Journal of Academic Research in Economics and Management Sciences. Under review.

Published and Presented Conference Full Paper

Al Hasani, M., Tularam, G. A., & Regan, M. (2017). Impacts of cultural risk factors on project success in the UAE construction industry. 22nd International Congress on Modelling and Simulation: Managing cumulative risks through model-based processes (MODSIM2017). *Modelling and Simulation Society of Australia and New Zealand, 3-8 December 2017, Hobart, Tasmania, Australia.* pp. 160-166. ISBN: 978-0-9872143-7-9. https://www.mssanz.org.au/modsim2017/A5/alhasani.pdf

Ethics Declaration

The research associated with this thesis received ethics approval from the Bond University Human Research Ethics Committee. Ethics application number 0000015806.

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I offer my regards and blessings to all of my supervisors, colleagues, friends and family who supported me during the completion of my study.

Thank you,

Mundhir AL-hasani

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List of Abbreviations

Abbreviation	Description
AD	Anno Domini
AIC	Akaike's information criterion
ANOVA	Analysis of variance
APM	Association for Project Management
AS/NZS	Australian/New Zealand standard
BCE	Before Common Era
BUHREC	Bond University Human Research Ethics Committee
CCIC	Canadian Construction Innovation Council
CD	Coefficient of determination
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CII	Construction Industry Institute
CIOB	Chartered Institute of Building
COSO	Committee of Sponsoring Organizations
CPI	Consumer price index
DETR	Department of the Environment, Transport, and the Regions

EFA	Exploratory factor analysis
ERM	Enterprise risk management
GAPPS	Global Alliance for Project Performance Standards
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GFI	Goodness of fit index
GMID	Global Market Information Databases
GOF	Goodness of fit
GSEM	Generalised structural equation Model
HOT	Human, organisation and technological
HR	Human resources
IBM	International Business Machines
IDV	Individualism versus collectivism index
IPMA	International Project Management Association
ISESCO	Islamic Educational Scientific and Cultural Organization
ISO	International Standards Organization
IT	Information technology
ITS	Information technology services
KPIs	Key performance indicators
KSA	Kingdom of Saudi Arabia

LOCOG	London Organising Committee of the Olympic and Paralympic Games
LTO	Long-term orientation
MAS	Masculinity versus femininity
MEED	Middle East Economic Digest
NAO	National Audit Office
NFI	Normed fit index
OECD	Organisation for Economic Co-operation and Development
OIT	Office of Information and Technology
PAC	Public Accounts Committee
PDI	Power distance index
PFIs	Private finance initiatives
PhD	Doctor of Philosophy
PLC	Project life cycle
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMP	Project management plan
PPPs	Public-private partnerships
PRAM	Project Risk Analysis and Management
PRINCE2	Projects in Controlled Environments, version 2
Q	Question

QDA	Qualitative data analysis
R&T	Resources & Technology
RAK	Ras Al-Kheimah
RBS	Risk breakdown structure
RIP	Regulatory, infrastructural and political
RM	Risk management
RMP	Risk management process
RMSEA	Root mean squared error of approximation
SEM	Structural equation model
SRMR	Standardised root mean squared residual
SWOT	Strengths, weaknesses, opportunities and threats
TLI	Tucker–Lewis index
TOPERs	Technical, organisational, project and external risks
UAE	United Arab Emirates
UAI	Uncertainty avoidance index
UK	United Kingdom
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States

Chapter 1: Introduction

1.1 Background of the Study

The construction industry is an essential part of the economy due to its significant contribution to employment and the construction of new housing, buildings and infrastructure, as well as the maintenance of existing structures (De Araujo *et al*., 2017; Yusof *et al*., 2016). Further, construction is one of the most risky, difficult and effective industries (Ehsan *et al*., 2010; Flanagan & Norman, 1993; Ghahramanzadeh, 2013; Hanna *et al*., 2013; Hwang *et al*., 2017; Iqbal *et al*., 2015; Liu *et al*., 2016; Lyons & Skitmore, 2004; Mills, 2001; Sambasivan *et al*., 2017; Serpella *et al*., 2014; Zhi, 1995). It is characterised by intensive financial input, complex procedures, long project durations, risky environments and partner relationships (Panthi *et al*., 2009; Sears *et al*., 2015; Ziyu *et al*., 2017). These characteristics, along with the multi-organisational nature of construction projects, create a high-risk business environment, with a variety of risks that significantly vary across countries and from one project to another (Rasheed *et al*., 2015). These risks may include uncertainties associated with climate and weather, the location and duration of projects, workers' motivation, expertise and qualifications, communication issues, local laws and regulations, economic and financial factors, and a variety of local cultural and religious matters (Akanni *et al*., 2015; Al Mousli & El-Sayegh, 2016; Kivrak *et al*., 2009; Zarrouk *et al*., 2017). Multinational organisations are particularly prone to construction risks because they must navigate and consider legal and regulatory issues in different countries as well as political matters, traditions, cultures and educational backgrounds, and different business and workplace environments (Akanni *et al*., 2015; Al-Hejji & Garavan, 2016; Bambang, 2017; Deloitte, 2016; El-Sayegh, 2008; Odongo *et al*., 2012). Navigating these challenges can be particularly difficult for Western companies in Middle Eastern construction markets, which are characterised by a significantly different culture, business and workplace environment.

Every human action in life involves risk, which is of great concern as it involves uncertainty and unpredictability. However, risk also prepares individuals for challenges. Risks lead to success and failure, although the extent of failure cannot be explained using precise terminology (Cooper *et al*., 2014; Dey, 2009; Szymanski, 2017).

Risk is typically defined as a potential occurrence (event, condition or circumstance) that is uncertain in likelihood and consequence and, if it occurs, could affect the achievement of one or more planned objectives (Harvett, 2013; Loosemore *et al*., 2006; McNeil *et al*., 2015). Some sources consider risks as potential occurrences that have both negative and positive effects on the expected objectives (Hillson & Murray-Webster, 2012; Project Management Institute [PMI], 2013). The definition of risk used in this thesis was proposed by the PMI (2013, p. 46) and considers both negative and positive aspects of risk, as follows: "[risk is] *an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality*." This definition is adopted in this thesis because it explicitly references projects. This will be consistent with the modelling used in this research (discussed in Chapter 5), in which risks and risk factors might have positive or negative effects on a project's success. Project success is the completion of a project's objectives on time, within the agreed budget and following expectations of safety and quality (Alias *et al*., 2014; Atkinson, 1999; Baccarini, 1999; Davis, 2017; Meng, 2012; Shenhar *et al*., 2001).

Risks can be static or dynamic, epistemic or aleatory (Blackman & Featherstone, 2015; Hillson, 2004a, 2004b; Kahneman & Tversky, 1979; Koleczko, 2012; McNeil *et al*., 2015; Song *et al*., 2007). A risk may be an event that emerges during a project or something that might have been known prior to the commencement of a project (Hanna *et al*., 2013; Muriana & Vizzini, 2017). Although risks are typically unknown, they can be reasonably estimated and analysed to better inform project design and implementation (Jannadi & Almishari, 2003; Muriana & Vizzini, 2017; Ziyu *et al*., 2017), thus ensuring the project's success.

Risk management that is based on a well-informed and consensual decision-making process is a critical part of any industrial project (PMI, 2013). It helps to achieve a project's outcomes more economically and effectively (Loosemore *et al*., 2006; Wibowo & Taufik, 2017; Szymanski, 2017). This is particularly the case in construction project management. Using a risk management framework to identify and mitigate risks to meet a project's objectives is the most comprehensive and systematic strategy for risk management (Serrador & Turner, 2015). Chapter 2 presents the definitions of risk management proposed by Projects in Controlled Environments 2 (PRINCE 2), along with different definitions of risk management used in other studies. Risk management is referred to as "*the systematic application of procedures to the tasks of identifying and assessing risks, and then planning and implementing risk responses*" (PRINCE 2, 2009, p. 176).

1.2 Study Rationale

Some of the fastest growing cities in the world are in developing countries. According to Smith (2002), construction industries in developing countries are significantly different from those in developed countries because of differences in climatic characteristics, availability of materials and equipment, financial and economic environments, human resources (HR) and cultural factors. Nonetheless, in the modern era of globalisation, successful economic development and progress in developing countries are essential for global economic prosperity. Middle Eastern countries play a role in the world economy because of their extensive oil reserves (which is one of the major resources driving economic development worldwide) and the long-term social and political instability of the region. Successful economic and social development in this region could be a pathway to greater economic and political stability worldwide. This highlights the significance of extensive research efforts aimed at developing effective tools for business and industry management in the Middle Eastern countries, particularly in construction industries.

Over the last four decades, Middle Eastern countries in the Gulf Cooperation Council (GCC, which are, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE) have experienced an unprecedented construction boom that has been particularly strong in the UAE (Deloitte, 2016; El-Mallakh, 2014; El-Sayegh, 2014). For example, as of May 2016, construction projects in the pre-execution stage in GCC countries amounted to more than US$2 trillion, with the UAE capturing around 34.84% of the total value of these projects (Figure 1.1).

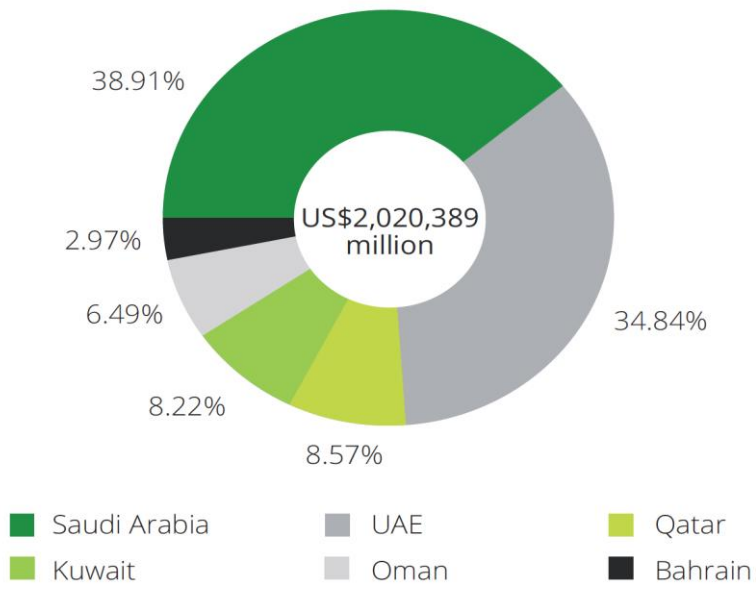


Figure 1.1: The Overall Value of Construction Projects in Pre-execution in the Gulf Cooperation Council Countries as of May 2016
Source: Deloitte (2016)

The UAE is the second-largest economy (after Saudi Arabia) among the GCC countries (Deloitte, 2016). This illustrates the importance of UAE industries, including the construction industry, for stable and healthy economic development in the Middle East.

Further, the UAE has unique economic and cultural characteristics compared to other countries in the Middle East and around the world. This uniqueness relates to the highly diverse cultural and ethnic mix in the workforce, with expatriates from 132 countries constituting 88.5% of the total workforce (Al Ariss & Guo, 2016; Human Development Report [UNDP], 2016). In addition to this, the UAE is characterised by a large proportion of multinational or overseas organisations that operate in the UAE construction market and/or invest in UAE construction businesses and projects (Al-Malkawi & Pillai, 2013; Bodolica *et al*., 2015; Rehman, 2008). These economic and cultural characteristics create a unique risk environment in the UAE construction industry, and detailed study and understanding are essential for continuing growth of the industry and its successful contribution to social stability and economic development in the Middle East and adjacent regions.

Abundant oil resources in the UAE have fuelled its rapid economic development. Current government policy in the UAE focuses on decreasing the dependence of its economy on oil through economic diversification into other sectors such as industry, tourism and commerce (Deloitte, 2016; El-Mallakh, 2014). As a result, significant amounts of revenue from oil sales have facilitated heavy investments into large projects and developments in the UAE construction industry (Charfeddine & Ben Khediri, 2016), with construction projects rapidly growing in complexity and size. This has led to an increasingly risky construction environment (Al Mousli & El-Sayegh, 2016). Owners expect their ambitious projects to be completed in the shortest possible time. Which places additional pressure on contractors and designers, resulting in higher construction risks.

Even in this modern era, many construction firms in the UAE have little knowledge of how to measure risk or of reliable tactics that can be used to eradicate or alleviate risk. One of the main reasons for this is the lack of government policies that aim to alleviate risk in the construction industry (Zaneldin, 2006). Most construction management scholars, however, recognise risk management as one of the most necessary elements of project management (Al Harthi, 2015; Lyons & Skitmore, 2004; Mills, 2001). Therefore, numerous researchers and research groups have attempted to identify and characterise construction risks in the UAE to improve risk management approaches and strategies and boost the success of construction projects (Al Ariss & Guo, 2016; Al-Hejji & Garavan, 2016; Al Mousli & El-Sayegh, 2016; Al-Sabah *et al*., 2014;

El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Faridi & El-Sayegh, 2006; Ling *et al*., 2012; Motaleb & Kishk, 2010, 2013, 2015).

1.3 Research Gaps and Research Questions

As explained in the previous section, there is an impressive body of literature on risk management in construction industries (including in the UAE). However, these studies only represent initial steps towards the detailed analysis and characterisation of construction risks and risk management practices in the Middle Eastern region (Al Mousli & El-Sayegh, 2016; Biygautane, 2017; El-Sayegh, 2014). Only a limited systemic quantitative characterisation of construction risks has been conducted to date in the UAE (and in other countries). This is because properly identifying, evaluating and characterising such risks requires sophisticated statistical methods for the analysis of multiple mutually correlated and potentially interacting variables resulting from survey measurement instruments. As explained in more detail in Chapter 3, consideration of simple regressions and/or correlations for selected pairs of variables is likely to be misleading and to provide incorrect outcomes and findings. To reliably establish and characterise causal relationships between variables obtained using survey instruments, approaches such as factor analyses and structural equation modelling (SEM) may be used (Xiong *et al*., 2015).

To date, the methods used to analyse and characterise risks have mostly been limited to basic comparisons of specific risks directly identified by individual survey items. These methods usually involve the relative importance index and mean criticality index (Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014; Enshassi *et al*., 2009; Motaleb & Kishk, 2010), Spearman correlation coefficients (Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016) and direct risk-taking and weighted risk scores (Kartam & Kartam, 2001; Lyons & Skitmore, 2004). The major problem with these approaches is that they cannot establish any causal relationships (or effect paths) between, and the mutual effects of, multiple risks (Chapter 3), and they do not allow proper adjustments for numerous survey-measured variables. As a result, previously identified risks (including economic and cultural risks and risk factors) and their quantitative characteristics are likely to be unreliable and inaccurate because of possible confounders. The same arguments apply to approaches based on response frequencies and mean risk scores (Odongo *et al*., 2012), simple regressions for pairs of variables (Harvett, 2013) and Kendall’s coefficient of concordance (Enshassi *et al*., 2009).

In addition to this, the determination and comparisons of specific risks based on individual survey items are prone to errors and inaccuracies caused by different formulations of survey items and participants' perceptions. Even well-formulated survey items can be misinterpreted and/or misperceived by participants. This is particularly a problem in a culturally diverse sample of participants (such as the one derived from the UAE workforce). Further, there is a wide diversity of previous outcomes (Khodeir & Mohamed, 2015; Musa *et al*., 2015) and, at times, they exhibit inconsistency with each other (including definitions and justifications of specific risks). This means that findings derived from the analysis of individual survey items may be inaccurate because of their formulation and misperception. This difficulty can be overcome by considering multiple similar items that reflect the same common aspects of construction risks but are formulated from different perspectives. The common aspect of the multiple items will then form a factor (construct or latent variable) (Yong & Pearce, 2013) that can be analysed with greater rigour and certainty because its numerical characteristic (factor score) is obtained as a kind of averaging over multiple items (Bollen, 1987; DiStefano *et al*., 2009; Stegmann, 2017).

Unfortunately, few studies have used advanced statistical methods such as factor analysis and SEM to investigate and characterise risks in construction industries (Chandra, 2015; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Sambasivan *et al*., 2017; Wang *et al*., 2016) and none have been related to risk identification and evaluation in the UAE construction industry. This constitutes a significant gap in the current knowledge of risks in the UAE construction industry.

Further, no studies have adjusted their outcomes for participant and/or company demographic variables. This is because the studies used SEM, which does not allow the involvement of categorical variables, including participant and/or company demographic variables (StataCorp, 2015). Wang *et al*. (2016) attempted to include some participant demographic variables by constructing a factor using the measurable variables of age, education and income. Unfortunately, these variables were considered categorical variables, and their use in SEM to construct a factor was unjustified and inappropriate (StataCorp, 2015). The lack of proper adjustments of SEM outcomes for demographic and company variables further widens the current knowledge gap in risk management research in the construction industry in the UAE and around the world.

It is important to note that this knowledge gap is not just about the lack of an appropriate methodology for the analysis. The lack of such a methodology demonstrates the lack of valid and reliable outcomes in terms of risk management in the construction industry, including in the UAE. Further, previous attempts to analyse construction risks resulted in a wide diversity of outcomes (Khodeir & Mohamed, 2015; Musa *et al*., 2015) that were, at times, inconsistent with each other (including varying definitions and identifications of specific risks). Thus, a systemic approach to risk management in construction industries based on valid and reliable statistical methods is required to close the knowledge gap in risk management research.

Although several studies of risk management have identified cultural risks and cultural diversity risks in the UAE (Al Ariss & Guo, 2016; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014; Khan, 2014; Ling *et al*., 2012), only superficial analysis of these risks based on the limited (and, in many cases, purely qualitative) methodological approaches has been undertaken to date. Further, as explained in Section 1.2, culture-related risks are expected to be particularly significant and severe in the UAE construction industry. The lack of clear quantitative characterisations of such risks, the determination of their effect paths and prevalence in the industry constitutes another significant knowledge gap that may be particularly wide and detrimental to further development of the UAE construction industry and its broader economy.

Finally, rather limited and non-systemic research efforts have aimed to identify and characterise mitigation strategies in risk management in the UAE and elsewhere. Further, the development of optimal mitigation strategies is an essential part of risk management research because it enables the effective practical application of knowledge to improve risk management practices, project success rates and efficiency of construction industries (including in the UAE). Limited systemic research efforts to understand, improve and optimise risk management practices and explore stakeholders' practices and perceptions to that effect in the UAE construction sector illustrate another significant knowledge gap (including both qualitative and quantitative research). Kutsch and Hall (2010, p. 249) highlighted this knowledge gap, noting: *"There appears to be far more literature offering prescriptions to project managers about how to manage risk in projects, rather than assess the relative effectiveness of those prescriptions."*

The identified and described knowledge gaps in research in the construction risk management area give rise to the following research questions considered in this thesis:

1. What are the major risks and risk factors (including any cultural and economic risks) and what are their effects on UAE construction projects?
2. What are the major risk management practices in the UAE construction industry and what are their effects on project success and management?

3. What are the effects of demographic and company variables on project success in the UAE construction industry?
4. How can risk management practices in UAE construction projects be improved?

These questions will be investigated by examining the differing perspectives of the three main categories of actors: clients, contractors and consultants. These categories are discussed in more detail in Chapter 2. The research questions of this study are framed by reviewing the literature and are presented at the end of the following chapter.

1.4 Research Aims and Objectives

1.4.1 Aim

The general research aim of this study is to undertake detailed quantitative and qualitative analyses of risks and risk factors in the UAE construction industry, risk management practices and possible improvements in the specific environment of the UAE, and the development of practical recommendations for better management of risks and greater success of construction projects. To achieve this aim, this thesis has the following seven key research objectives:

1.4.2 Objectives of the Study

1. Develop and characterise statistical constructs (risk factors) representing the major types of construction risks and risk management practices in the UAE.
2. Determine quantitative relationships between risk management practices and their outcomes, adjusted for demographic and company variables.
3. Develop path networks for direct and indirect causal effects of cultural and economic factors on project success in the UAE construction industry.
4. Identify and characterise the most critical risk factors and specific construction risks in the UAE.
5. Conduct qualitative analysis and validation of the quantitative findings and identify any additional potential risks in the UAE construction industry.
6. Qualitatively identify and analyse strategies to improve risk management in the UAE construction industry.
7. Develop specific recommendations for private and government organisations in the UAE regarding optimal strategies to reduce risks and further improve risk management in the construction industry.

The research plan for this study is outlined in Figure 1.2. This plan acts as a guide for the researcher throughout the research.

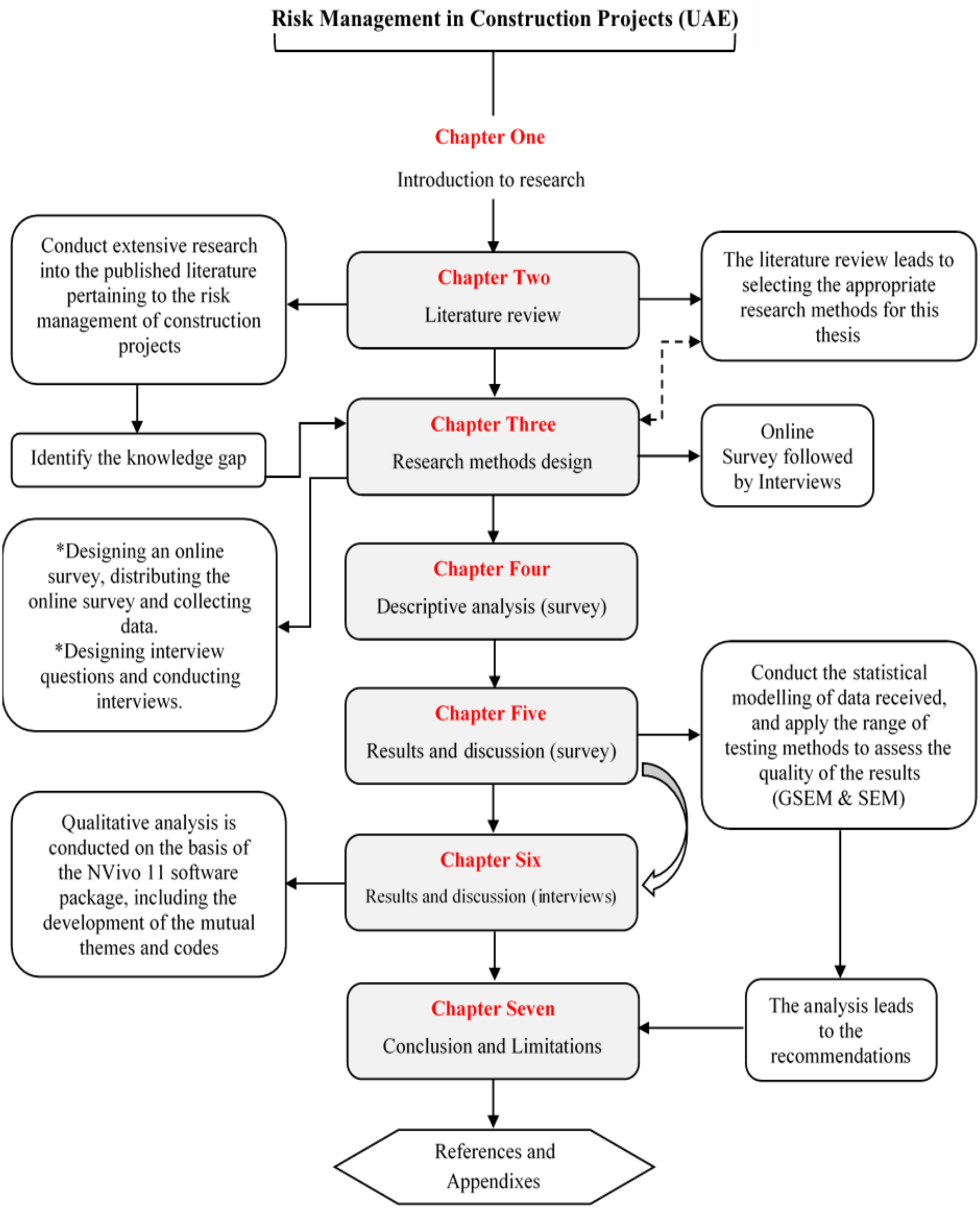


Figure 1.2: Research Plan

Source: Author (2018); Cerimagic (2012)

1.5 Significance and Novelty

As explained in Section 1.2, the UAE has experienced unprecedented growth in construction activities over the past four decades (Deloitte, 2016; El-Mallakh, 2014; El-Sayegh, 2008, 2014). This has significantly increased the need to manage the industry in an optimal way to ensure smooth development for the benefit of the UAE economy and economies in the wider Middle East region.

This study significantly addresses a highly important and urgent problem—the improvement of management and efficiency in the UAE construction industry. The outcomes and findings of this research (including recommendations for the government and industrial organisations) constitute a step towards the better identification, understanding, characterisation and practical management of risks in construction. These outcomes and recommendations are expected to significantly improve current risk management practices in the UAE construction industry and to improve the efficiency and rate of success of current and future construction projects. This is especially significant in the UAE construction industry, where approximately one-third of all construction projects show poor performance (Issa, 2014).

In addition to this, this study may expand the horizons of the application of quantitative approaches (based on factor analyses and generalised SEM) in risk management research, including their capacity to involve a variety of demographic and company variables to achieve reliable characterisations of risks and their effects on project success. The significance of this methodological advancement is not limited to the context of the UAE construction industry: the methodological approaches described, demonstrated and extensively used in this study can enhance our knowledge in risk management research and improve management strategies in a variety of countries and industries. Thus, this study contributes to current general knowledge of risk management research. Its findings and outcomes are also expected to assist with developing practical and useful guidelines for risk management in the specific context of the UAE construction industry and those of other countries.

This study is novel because, unlike the previously discussed literature sources, it applies advanced statistical methodologies based on factor analyses and generalised SEM to reliably and consistently identify and characterise risks, risk factors and risk management practices in the construction industry. The analytical methodology facilitates a new perspective and a reliable quantitative characterisation of the networks of causal effects of cultural, economic and other risks and risk factors on each other and on the success of construction projects—all properly adjusted for demographic and company variables.

Further, for the first time, the networks of direct and indirect effects of cultural, economic and other risks and risk factors are considered and systematically analysed and characterised in the UAE construction industry. As a result, current knowledge has been enhanced in risk management research in the UAE. An example of the major novel findings is the particularly strong negative effects on project success from all risks associated with the cultural diversity of the workforce in the UAE (except for different educational backgrounds), which occurred indirectly through the mediation of external and internal risks and communication deficiencies.

Some researchers have attempted to identify strategies to improve risk management in the UAE construction industry (Al Mousli & El-Sayegh, 2016; Al-Sabah *et al.*, 2014; El-Sayegh, 2008; Ling *et al.*, 2012). However, the conclusions and findings of such strategies have mainly been drawn based on risks identified directly from the survey instruments or interview data. To date, few studies have focused on directly identifying improvement strategies without any direct relevance or reference to specific risks. Therefore, a novelty of the current study is its attempt to fill this gap by conducting direct qualitative identification and analysis of possible strategies to further improve risk management practices and outcomes in the UAE construction industry. The qualitative analysis is also extended to identify additional construction risks/issues potentially missing from the quantitative analysis and previous studies. This results in the identification of at least 11 additional issues that will require further quantitative investigation in the context of the UAE construction industry.

1.6 Structure of the Thesis

This section briefly outlines the structure of this thesis, including the content and purpose of each of the seven chapters, as shown in Figure 1.2.

Chapter 1 describes the background to the research. It also outlines the rationale, research gaps and the research questions, aims and objectives. Finally, the significance and novelty of this study are stated.

Chapter 2 examines the extensive body of literature related to the overview of the UAE, culture in Arab and Western countries and evaluation of the UAE construction sector. The chapter reviews the relevant literature on project and management with an emphasis on construction projects as the context of this thesis. The chapter defines the concept of risk in general and from the perspective of construction projects. The risk management process is also defined, along with its sub-processes. The literature review focuses on the factors affecting the risk management process. Further, the chapter discusses the economic and cultural factors at a national level as well as the criteria for successful construction projects. Furthermore, this chapter presents the findings of other researchers and the classification of construction risks and reviews related to studies undertaken by these researchers. Finally, this chapter compares construction performance in UAE and other countries and detailed implications review and identifies significant gaps in the knowledge.

Chapter 3 discusses the aims and research questions and the research methodology used to answer the research questions are described. The research approach is then defined and the rationale for the choice of the research design is discussed. The sample selection and data collection methodology are outlined and the sample size for the questionnaires and interviews explained. In addition to this, the chapter identifies the data analysis, statistical analysis and mathematical analysis methods used. Finally, it outlines the material facts and ethical considerations of the thesis.

Chapter 4 provides a descriptive analysis of the preliminary summary statistics analysis of the questionnaire data to understand the basic structure of the available sample and the composition of the participating cohort. This provides a preliminary understanding of potential significant relationships and trends between the variables (which will be verified and confirmed using generalised structural equation modelling (GSEM) and the confirmatory factor analysis (CFA) modelling).

Chapter 5 presents and discusses the major quantitative outcomes of the statistical modelling of the survey data, including a description and interpretation of the major statistical constructs associated with risk management in UAE construction projects. The first analytical step is to develop, validate and discuss the constructs (factors) associated with risk management and the successful completion of construction projects. The second step is to develop SEM and GSEM models involving the constructs and other company variables as well as socio-economic variables. The third step is to discuss and quantitatively characterise direct and indirect effects between the variables and constructs. This step will also include interpretations of the outcomes and causal relationships between the constructs and variables involved, identification of the most important and significant risks associated with the development of construction projects in the UAE context and comparisons with the findings of previous studies.

Chapter 6 describes the qualitative analysis, which is conducted using the NVivo 11 software package, including the development of mutual themes and codes associated with existing risks and their management practices in the UAE construction industry. It also presents quotations from participants relating to the topic. This chapter also explains the findings from the interviews and compares them with findings from the literature.

Chapter 7 provides an overall summary of the thesis and the conclusions based on the results of the data analysis. It then summarises the major quantitative and qualitative findings and formulates recommendations for the industry and organisations. Lastly, the chapter outlines directions for future research and the limitations of this study. Having established the broad context of this study and its structure, Chapter 2 comprises a review of the literature which underpins the study.

Chapter 2: Literature Review

2.1 Introduction

In the previous chapter, the background to the research, the rationale, research gaps and research questions, aim, objectives, significance and novelty of this study were stated and the overall structure of the thesis was outlined. This chapter will begin by closely examining the UAE before reviewing the relevant literature on project management with an emphasis on construction projects as the context of this thesis. The concept of risk in general and in the context of construction are explained and the risk management process and sub-processes are discussed. This chapter then focuses on the factors affecting the risk management process, outlines the classification of construction risks and discusses the success criteria for construction projects. Furthermore, studies by other researchers and their findings in the context of construction risk management are described. Finally, this chapter provides a detailed implications review and identifies significant gaps in the knowledge.

2.2 Introduction to the United Arab Emirates

Seven territories, covering 83,600 square kilometers situated in the northern Arabian Peninsula on the southern rim of the Persian Gulf (also known as Arabian Gulf), form the seven confederated Emirates of the UAE. This area is also called ‘the Emirates’. As shown in Figure 2.1, the UAE shares borders with Qatar, Saudi Arabia and Oman. Named after their capital cities, the Emirates (from west to east) are Abu Dhabi, Ajman, Dubai, Fujeirah, Sharjah, Ras al-Kheimah and Umm al-Quwan (Behery & Paton, 2008).

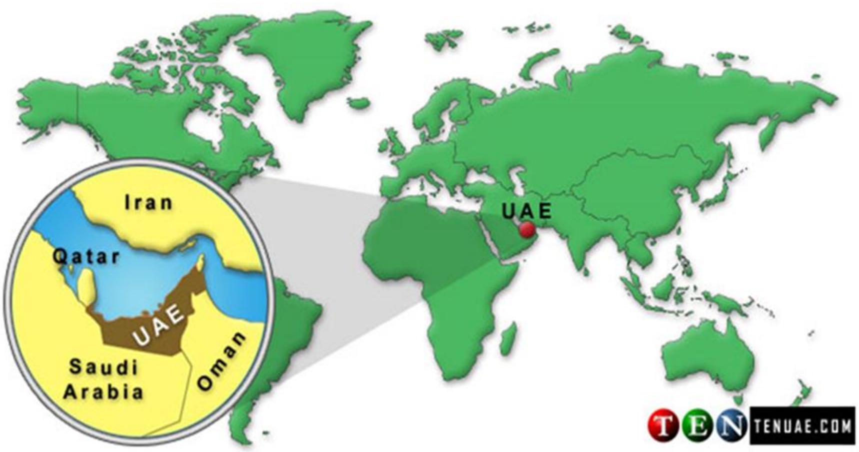


Figure 2.1: Map of United Arab Emirates

Source: The XYZ Maps Company (2016)

The written history of the seven Emirates, dating from their Islamic conversion in 632 AD, reveals that the people in the region were socially organised along tribal lines that remained largely unchanged until 1962, when oil was discovered in the coastal waters off Dubai (Sbia & Alrousan, 2016). Founded as a sovereign state in 1971, the UAE has strikingly transformed itself in less than 50 years from a loosely populated, mostly Bedouin backwater into a burgeoning symbol of economic change and modernity, not just for the Middle East, but for the world. In the UAE's short history as a nation, the global economic community has come to recognise and admire its commitment to the strategic development of its core industries and the vision to sustain itself in the post-oil era through the diversification and development of its industries. One part of the UAE's vision for development has been to put in place economic reforms that will maximise its strategic initiatives; for example, the Emirates have created the largest free trade zone in the world. The UAE's commitment to rational progress has resulted in many large multinationals basing their home in the region, particularly in Dubai (Sbia & Alrousan, 2016; Sbia *et al.*, 2014; Toledo, 2013).

According to the UAE Ministry of Economy (2015), the UAE is the most prosperous economy in the Middle East on a per capita basis. The primary sources of this wealth are Abu Dhabi's oil reserves and Dubai's strong manufacturing, tourism and financial services sectors. The significance of such wealth becomes especially clear upon consideration of the Emirates' population statistics. Sgouridis *et al.* (2016) state that the UAE's total population in 2016 was roughly 9.4 million. The World Population Review (06, August 2016) reported that 90% of this population consists of immigrants and expatriates. Such wealth concentrated essentially for the benefit of a very few has permitted the country to resist the social change, such as democratisation and social order, that have challenged their regional neighbours.

Further, the country's openness to the immigration of people from diverse nationalities is continuing, encouraged by a relatively liberal social environment. As noted by Hofstede (1991, p. 186), throughout the UAE's quite short history, *"People from different countries and different walks of life have traded and made productive deals while pursuing their own very different goals."* Petroff (2006) and Virick and Greer (2012) both point to the mixed virtues of diversity, in that, on the one hand, it can spark creativity and efficiency, while on the other it can also create excessive competitiveness and conflict. As Stroh and Caligiuri (2000) and Hills and Atkins (2013) note, a considerable majority of the non-citizen community is male; recently, however, more women have joined the expatriate workforce. One must, therefore, note the potential for heightened risk that cultural diversity poses to long-range planning in the UAE.

The capital of the UAE is Abu Dhabi, its largest and richest emirate, which in 2016 had a population of 2,784,790 (World Population Review, 2016). Its wealth can be attributed to ownership of 90% of the UAE's oil and natural gas reserves. The UAE ranks fifth (9%) in ownership of the world's total oil and gas reserves and of that, Abu Dhabi owns 94% (Al-Maamary *et al.,* 2016). Despite its wealth, Abu Dhabi has joined aggressively with other Emirates in advancing the diversification of its economic potential (Dulaimi & Hariz, 2011; Rehman, 2008).

Dubai, occupies 5% (3,885 square kilometers) of the UAE's land area and produces substantial revenue from tourism and business and financial services. This is made possible by modern, non-restrictive financial regulation applied in connection with the Jebel Ali Free Trade Zone (Walsh, 2008). Dubai is the preferred location within the region for multinationals' regional offices. This preference is rooted in Dubai's modern infrastructure, dynamic business culture and accommodating lifestyle for expatriates. Dubai's culture is strongly oriented toward business and toward the travellers and expatriates who conduct it. It has created a visually and socially attractive infrastructure that accommodates the business needs and social requirements of the multinational firms for whom it is a source of reliable business support. For firms doing business principally within the Middle East, it is common to create a home office in Dubai and have reporting locations strategically placed to allow Dubai to function as a hub (Al-Darmaki *et al.,* 2016; Dulaimi & Hariz, 2011).

Each of the remaining five Emirates is unique in its own way, beginning with Ajman, the smallest. Covering about 260 square kilometers, Ajman is entirely urbanised and has a population of approximately 240,000, of which roughly one-third are nationals and two-thirds are expatriates (World Population Review, 2016). Ajman's real estate market was opened to international investors in 2004, which occasioned a boom that proceeded without regulation until 2008, when the Ajman real estate market crashed (Hills & Atkins, 2013). As of 2015, many projects had been restarted, including an airport and a marina, but in a much more measured and careful way (Oeti, 2015). At the same time, Ajman has been establishing its tourism capacity as the city of Ajman increasingly becomes a major regional city (Sbia & Alrousan, 2016).

Fujeirah is separated from the other Emirates by the northern part of the Hajjar Mountains of Oman, and it is almost entirely mountainous (Cerimagic, 2012). This emirate is geographically unique in that it is home to a large commercial deep-water port that faces the Gulf of Oman and, therefore, has direct access to the Indian Ocean, avoiding the Strait of Hormuz. Much of the port is configured as a holding station for sheep and cattle for the entire Arabian Peninsula (Benesh, 2008). Having no oil, however, its economy is limited to crushed rock products, agriculture, fishing, boat-building, revenues from port fees and state subsidies (Al-Darmaki *et al.,* 2016).

Sharjah, unlike its glamorous confederates, portrays itself (and was declared so by UNESCO in 1998) as an Arab 'Capital of Culture' and, more recently, as the Islamic Educational Scientific and Cultural Organization (ISESCO)-designated Islamic Culture Capital in 2004. Its historical character is manifest in archaeological findings from early settlements dating to 7,000 BCE. Over the past 5,000 years, digs at Al Dhaid have yielded artefacts thought to date back hundreds of thousands of years (Bretzke *et al.*, 2016). Sharjah has dedicated itself to the restoration of its antiquities, especially its architecture, and to the work of its museums. Although it is better known for its cultural and intellectual bent than for its commercial development, it has aggressively grown its infrastructure and significantly advanced its industrial capacity, both of which have benefited from its oil and gas reserves and its advanced highway connections to Dubai and Ras al-Kheimah (Benesh, 2008).

Ras al-Kheimah (RAK), which is limited in its capacity to produce oil as it has only marginal reserves, has adopted diversification and laws to attract international investment. This forward vision has included significant port and airport enhancements. RAK has an active real estate sector, in which social housing plays an increasing role. Since the 1970s, RAK has increasingly turned to industrial projects, most notably as the region's largest producer of cement. More recent efforts have focused on the pharmaceutical development and advanced technology and RAK is also active in the ceramics, steel, glass and automotive industries (Mohsen *et al*., 2016). This emirate also embraces tourism, which has benefited from steady infrastructure improvement (Benesh, 2008).

Umm al-Quwan, although not the smallest of the Emirates, has the smallest population, of about 40,000 (World Population Review, 2016). Its agriculturally productive land is a significant source of poultry and dairy products and its coastal waters are notably rich; fishing has been a local industry for centuries. With no oil reserves, the emirate's commercial activities are fishing, boat-building and pearl-diving (Stanton *et al.*, 2012). Archaeology is active in Umm al-Quwan, as it was the focus of trading activity in 5,000 BCE, and heritage restoration and its associated infrastructure have recently emerged as a local industry (Bretzke *et al.*, 2016).

Considering the country as a whole, the reports of the Oxford Business Group (2017) strongly emphasise that deriving commercial benefit from the UAE is dependent upon a strategic outlook based on a profound understanding of regional culture. As Rehman (2008) and Zarrouk *et al.* (2017) note, not only must regional awareness be comprehensive and in-depth, it must also be current as the waves from global and Middle Eastern economics and geopolitics sweep the UAE and dramatically influence the drivers of economic development. One need looks no further for an example than the 2014 and continuing downturn in global oil prices, where decreasing in oil prices have resulted in high inflation and price volatility (Dubai Statistics Center, 2017).

Thus, although the region is politically stable, it exists within a broader context that is not. From this discussion emerges the general assessment that the key challenge faced by international and regional investors is the management of risk. Consequently, businesses must carefully assess the risks that challenge commercial activity and investment development and control these risks in a manner that will minimise disadvantageous performance and concomitant losses.

2.2.1 The Arab Culture and Religion

Schneider and DeMeyer (1991) note the many studies showing that with different national cultures comes variation in information technology (IT) projects, management practices, leadership styles (Andre & Miriam, 2016; Dorfman & Howell, 1988; Gencer & Samur, 2016) and human resource management (Luthans, 1995). These studies show that variations in risk management practices and national cultures have an impact on workplace performance.

In order to understand this impact, it is necessary to understand different societies, which is a complicated task. Each individual has a cultural identity that distinguishes him or her from other members of the same society, while each society has a cultural identity that distinguishes it from other societies. These identities and cultures differ in many ways including religion, beliefs, language, dress and arts. For example, a reference to ‘Arabs’ tends to conjure up the image of a person, religion and place based on how the media have portrayed Arabs. An Arab is normally thought of as a person who is Muslim and lives in one of the Arab nations or the Middle East (Abu-Hilal *et al.*, 2016; Retso, 2003). However, there is more to a person than where he or she came from: there are also other behavioural, cultural, historical and religious factors that need to be considered. The following section explores the definition of culture and discusses the five dimensions of culture.

2.2.2 Culture

The definition of 'culture' is different for different areas of study; for example, the fields of business management and the social sciences define 'culture' differently (Gencer & Samur, 2016). Scholars whose work deals with culture tend to agree that it is impossible to define 'culture' accurately and that trying to do so creates controversy (Abu-Hilal *et al.*, 2016; Cowan, 2006).

The term 'culture' comes from the Latin word *cultura*, which in turn comes from *colere,* which means 'to cultivate' (Macquarie Dictionary, 2016). This is the etymology most widely used by scholars. The Macquarie Dictionary defines culture as including anything relevant to human knowledge, belief and behaviour, such as the attitudes, values, goals and practices shared by a group of people in a specified place from generation to generation.

An individual's culture depends on a number of things, including the place and the society in which he or she was raised, including other factors that influence and affect daily life. In addition to these factors, an individual's culture is also a product of his or her unique set of experiences. The individuals who make up a culture are all different, yet their culture influences how they act, how they communicate and how they filter information. The larger a group is, the more slowly its culture develops (Oyserman, 2017; Murphie & Potts, 2003). Therefore, a culture cannot be summarised and limited to one single characterisation because it will be different for each person, each society and each field for which we try to use that concept.

A definition of Arab culture must be based on the word 'Arab', which conveys the fundamental attributes of Arab society. Early written sources describe 'Arab' as *"a term for groups of people in the Middle East"* who practise Islam (Andre & Miriam, 2016, p. 239).

Any culture designates some actions—such as men and women shaking hands— as normal and acceptable and others as abnormal or inappropriate. It is then important to understand a particular culture so as not to inadvertently cause offence. Cerimagic (2010), Kohls (1981) and Marquardt and Kearsley (1999) have all catalogued ways in which Western and non-Western cultures differ. As summarised in Table 2.1, these differences can affect how effective (or counterproductive) different types of motivation and training might be when managing international projects. Table 2.1 compares Western and non-Western cultural values and their impact on project management.

Table 2.1: Western and Non-Western Cultural Values

Western cultural value	Non-Western cultural value	Impact on project management
Achievement	Modesty	No impact
Action/doing	Being/acceptance	–*
Control	Fate	–
Directness	Indirectness	–
Equality	Hierarchy	–
Future/change	Past/tradition	–
Guilt	Shame	No impact
Individualism	Collectivism/group	+*
Informal	Formal	–
Pride	Saving face	No impact
Respect for competence	Respect for elders	–
Respect for results	Respect for status	+
Specific/linear	Holistic	+
Systematic/mechanic	Humanistic	–
Tasks	Relationship/loyalty	–
Time is money	Time is life	–
Verbal	Non-verbal	+
Winning	Collaboration	+

Note: "(+) = Positive impact of combining both value outcomes and (-*) = Negative impact of combining both value outcomes (culture clash)."*

Source: Adapted from Cerimagic (2012); Kohls (1981); Marquardt & Kearsley (1999)

For example, Australians are task-oriented and take the view that 'time is money'. They tend to see it as wasteful when the Arab managers on their construction projects hold meetings that last—as the Australians see it—longer than they need to. However, in Arab culture, time is not money: it is 'life'. The point of a meeting, then, is not so much the money and goals involved as it is the relationships involved. Establishing or maintaining relationships is not something one can rush. If a Western project manager does not understand this important aspect of Arab culture, the project will run into trouble due to the cultural clash. This can be seen in Table 2.1, which shows how differences between Western and non-Western cultures can result in a cultural clash occurring, which would impact on project management. Team members, therefore, need to be able to get work done and make decisions and judgements in light of culture and values different from their own.

A national culture belongs to a particular national group and permeates everyday life, which is why Hofstede (1980, p. 25) defines it as the "*collective programming or software of mind*." Low and Leong (2000) and Salzmann and Soypak (2017) observe that people tend to be unwilling to alter their national culture. When researching multinational companies, they observed that managers from different countries differ greatly in how to think about and behave toward their employees and that national culture has more impact on a person's work-related values and attitudes than his or her position, profession, gender or age (Andre & Miriam, 2016; Ferreira *et al*., 2014). In fact, according to Hofstede's (1991) world study, half of the differences in employees' attitudes and behaviour can be attributed to their national cultures.

In a survey of International Business Machines (IBM) employees, Hofstede (1980, 2015) observed five dimensions of culture:

1. Power distance index (PDI)
2. Uncertainty avoidance index (UAI)
3. Masculinity versus femininity (MAS)
4. Individualism versus collectivism index (IDV)
5. Long-term orientation (LTO)

These dimensions are discussed in detail below.

The PDI *"is the degree to which power differences are accepted and sanctioned by a society*" (Hofstede & McRae, 2004, pp. 52–88); that is, how authority, influence, power and equality are concentrated or distributed in a culture. Hofstede and McRae (2004, p. 52) describe this as follows: *"A high score on this scale indicates that society accepts an unequal distribution of power, and that people understand their place in the system. A low score indicates that power is shared and well dispersed. It also indicates that society members view themselves as equals."* Hofstede scored the UAE as 80 out of 100 on this measure. This suggests that the UAE's culture requires hierarchical management in which everyone has a place. People in that culture will accept inequality of power between organisations as well as between people. In a setting characterised by a high-power distance (Hofstede, 1973, 2015), project managers who hold a high rank in the hierarchical order will be respected and obeyed with minimal questioning. In a construction project, however, the hierarchy may be spread across different organisations and team members, making it necessary to understand the system in which they all operate. Australia, in contrast, scored 38 out of 100 on power distance (Hofstede, 2008a). Australians expect equality of power, seeing power distance in terms of the degree of hierarchy or level of decision-making.

The UAI is the "*degree to which a society is willing to accept and deal with uncertainty*" (Hofstede & McRae, 2004, p. 52); that is, how much ambiguity is considered acceptable in a particular society. A high score on this scale indicates that *"nations try to avoid ambiguous* *situations whenever possible. They are governed by rules and order and they seek a collective truth. A low score indicates that the society enjoys novel events and values differences. There are very few rules, and people are encouraged to discover their own truth"* (Hofstede & McRae, 2004, p. 88). In a culture characterised by a high level of uncertainty avoidance, people are uncomfortable with uncertainty and try to avoid it. Because Muslim culture has developed rules, laws and policies to reduce uncertainty (Hofstede & Meijer, 2007), the UAE scores 68 out of 100 on this index. This high score is changing, however, with the influx of Western businesses into the UAE (Bremer *et al.*, 2017). Australia, on the other hand, scored of 51 out of 100 on uncertainty avoidance (Hofstede and Meijer, 2007), which means that on average, Australians are more tolerant of situations that are unstructured or unpredictable than people from the UAE. High uncertainty avoidance is discussed further in Section 2.7.

Hofstede and McRae (2004, p. 62) describe the MAS cultural value as, "*Masculinity is the degree to which traditional male values are important to society*." Hofstede recommends that a manager who needs to motivate an employee of a culture that does not emphasise assertiveness will do better in conversation to speak more about that employee than about him or herself. This dimension relies on the separation of masculine and feminine traits. Masculinity comprises achievement, aggressiveness, drive for success and task-orientation, while femininity comprises the emotional, affiliated, submissive and relationship-orientated. Hofstede and McRae (2004) further explain: *"High MAS scores are found in countries where men are expected to be tough, to be the provider, and to be assertive. If women work outside the home, they tend to have separate professions from men. Low MAS scores do not reverse the gender roles. In a low MAS society, the roles are simply blurred"* (p. 77). Hofstede (2009) rated the UAE as 52 out of 100 on this scale, finding that in this Islamic culture, women have limited influence and it is important to 'save face'. Again, however, as the UAE's culture becomes more Westernised, women have more opportunities to be highly educated and hold positions of leadership. Hofstede scored Australia even higher: 61 out of 100. Australian culture is more in favour of sexual equality of behaviour that UAE culture, which sees more value in relationships, group decision-making, cooperation and quality of life.

The IDV is *"the degree to which individual decision-making and action is accepted and encouraged by the society*" (Hofstede & McRae, 2004, p. 60). A high score on this scale indicates the importance in that culture of independence and individual achievement. A low score indicates that members of that culture tend to act as 'collectivists'; that is, as group members rather than as themselves as individuals (Hofstede, 2008b, 2009). Hofstede gave the

UAE a score of 38 out of 100 on this scale. He found the UAE to be a collective society in which individuals look out for each other and attach more importance to the needs of their society than to the needs of a particular individual. In short, the culture of the UAE is characterised by a ‘greater good’ mentality and long-term commitment to the group. Such a culture values family, honour and hospitality highly. Managers of construction projects in the UAE must therefore invest in team dynamics, as the same people are likely to be working together in the future. Australia, on the other hand, has a rather individualistic culture. Australians tend to be much more concerned with their own goals and satisfaction than with those of the social group as a whole. Australia scored a much higher 90 out of 100 on IDV; in fact, it had the second-highest score on this dimension of any of the countries rated (the United States (US) was the highest, scoring 91.)

LTO measures the degree to which a society is or is not dedicated to long-term and traditional forward-thinking values. A high score on this index is the mark of a culture that “*subscribes to the values of long-term commitments and respect for tradition*” (Hofstede & Hofstede, 2004, p. 211). Figure 2.2 portrays these five dimensions graphically. Although Hofstede did not give the UAE a score for LTO, the assumption made is that it would have achieved a reasonably high score, based on a large amount of construction taking place. The shift from relying on oil to relying more on tourism are indicators of long-term thinking.

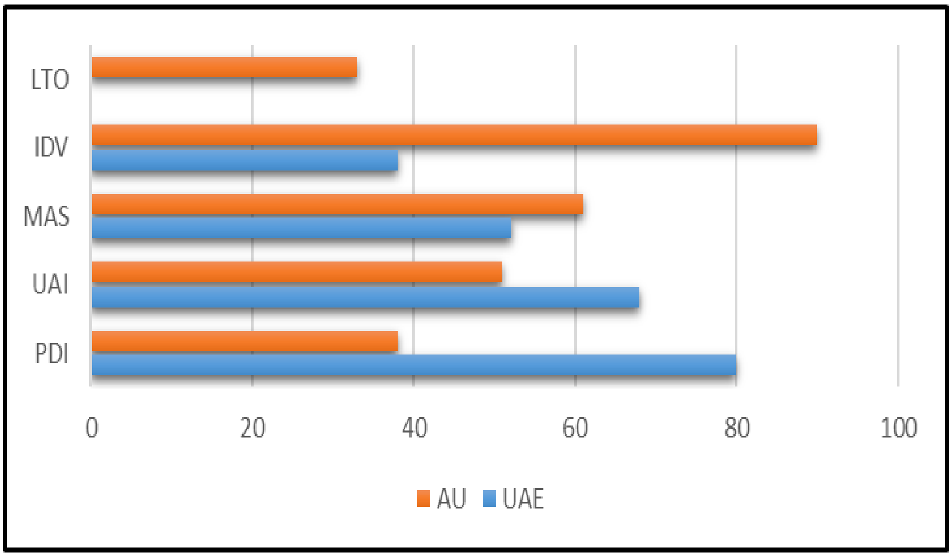


Figure 2.2: The Five Dimensions: Australia versus the UAE

Source: Adapted from Hofstede (2010)

Culture is, by definition, the response of a social group to its social environment (Hofstede, 1991, 2001, 2015). As described by Hickson and Pugh (1995, p. 90), “*culture shapes* *everything*." It is difficult, though, to define what exactly is meant by 'group'. Based on a study of organisational culture, Schein (1985) identified three layers of culture:

- Behavioural and artefact;
- Values and beliefs; and
- Underlying assumptions.

Many have concluded that management practices do not generalise from one culture to another (e.g., Triandis, 1994; see also House *et al*., 2004). Each employee has his or her particular collection of values, attitudes and beliefs which, as management researchers have found, serve as filters through which individuals observe and understand particular management situations. Such differences of viewpoint, grounded in cultural differences, are at work on construction projects. However, while Andersen (2016) notes that human behaviour differs from individual to individual and from situation to situation, it remains possible to find an underlying coherence.

Management researchers such as Andersen (2016), Cheung *et al*. (2003) and Adler (1991) have all identified the importance of behavioural issues to project managers. Andersen (2016) notes the importance of motivation, communication, loyalty and satisfaction in particular. Behavioural indicators can help project managers deal with matters of employee performance (Cerimagic, 2010). Management researchers such as Cheung *et al.* (2003), Meng and Boyd (2017) and Zulch (2014) assert that honesty, openness, communication, trust, cooperation and job satisfaction are of great value on construction projects (construction projects are defined in Section 2.5), where a concentrated cooperative effort is required. Adler (1997) notes the central importance of certain managerial behaviours: leadership, decision-making and motivation.

In sum, businesses must manage their risks appropriately with due consideration of culture and economic aspects to minimise business losses. Section 2.3, therefore, offers an overview of the UAE construction sector and explores the reasons for choosing the UAE as an appropriate context for this thesis.

2.3 An Overview of the UAE Construction Sector

The construction industry is booming in the UAE, with many multinational construction companies entering the market (Bodolica *et al*., 2015; Rehman, 2008). The construction industry is one of the most important sectors of the UAE economy, making a significant contribution to development. Through forward and backward linkages in the economy, it can also be considered an engine of economic growth. According to the UAE Ministry of Economy

(2015), between 2009 and 2015, 39% of total investment in the UAE was in construction and housing. As stated by Lopes (1998), investment in the construction sector is a major driver of economic growth, since it increases the demand for other industries such as steel, cement, electronics and machinery. Moreover, construction's wider significance for the economy can be attributed to its products and services, which generate substantial economic benefits, including the buildings in which other businesses operate (UK Construction, 2013). Statistics published by Global Market Information Databases (GMID) (2015) demonstrate that over the period of 2009 to 2015, the UAE's construction sector contributed about 11.1% of the country's gross domestic product (GDP).

The construction industry plays a significant role in the structure of the UAE's economy, alongside healthcare, tourism, sports, education and hospitality (El-Mallakh, 2014). More than $200 billion is invested annually in oil, gas, power, industrial, transport, commercial and residential buildings, environment and communication construction projects (Al-Malkawi & Pillai, 2013). This investment is occurring because demand for these products is growing (Charfeddine & Ben Khediri, 2016). In total, approximately $5 billion was invested in construction projects in the United Arab Emirates in 2015 (Deloitte, 2016).

The UAE has spent around $124 billion to develop 325 artificial islands (shown in Figure 2.3); for example, Al Saadiyat, the Jebel Ali Palm, Deira Palm, World Islands, and Mangrove and Fujeirah Islands (MEED Insight, 2015). Table 2.2 lists some of the construction projects in the UAE that have been supported by the government.

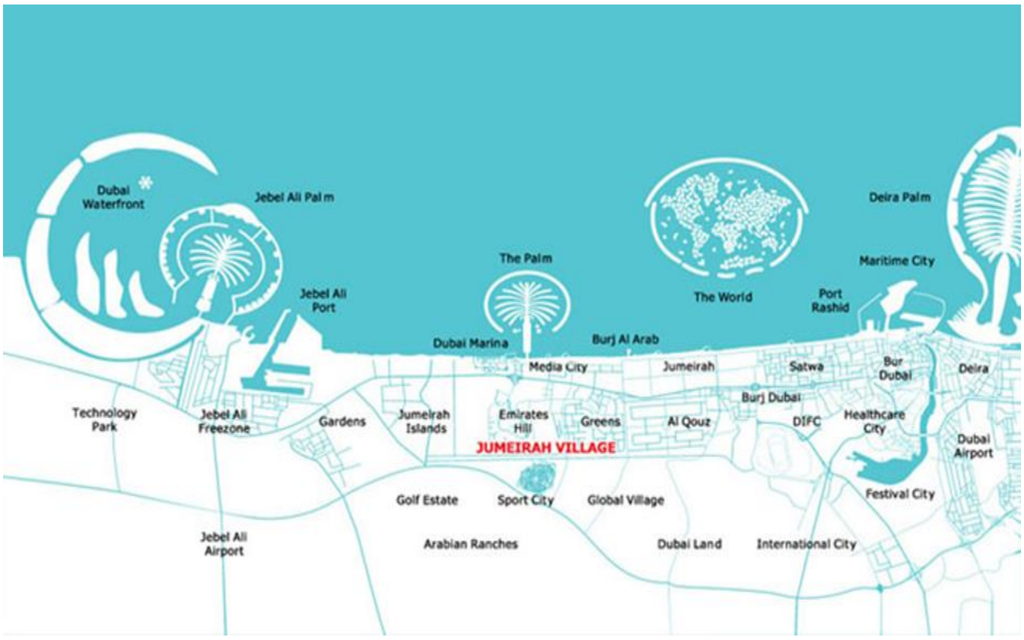


Figure 2.3: Artificial Islands in the UAE

Source: MEED Insight (2015)

Table 2.2: Selected UAE Construction Projects

No	Project Name	USD (Total cost in billion)
1	Dubai metro	14.35
2	Emirates roads master plan	12.00
3	Dubai international airport expansion	7.80
4	Abu Dhabi airport expansion – midfield terminal	2.96
5	Abu Dhabi metro	7.00
6	Causeway between Qatar and Dubai	13.00

Source: MEED Insight (2015)

As highlighted in Table 2.2, the UAE has invested significantly in the development of transport-related construction projects. While this investment comes as a result of expanding the land area of the UAE, it also is driven by an increase in visitors to the region that is projected to result from hosting Expo 2020. This is expected to attract over 25 million visitors to Dubai and Abu Dhabi over a six-month period, increasing the profile of the region globally. The cost of preparing the city for this event is expected to reach between \$2 and \$4 billion (MEED Insight, 2015). Consequently, government investment in projects in Dubai and Abu Dhabi is increasing, as shown in Figures 2.4 and 2.5. Figure 2.4 shows the distribution of construction projects amongst the Emirates, while Figure 2.5 shows the growing investment in construction projects.

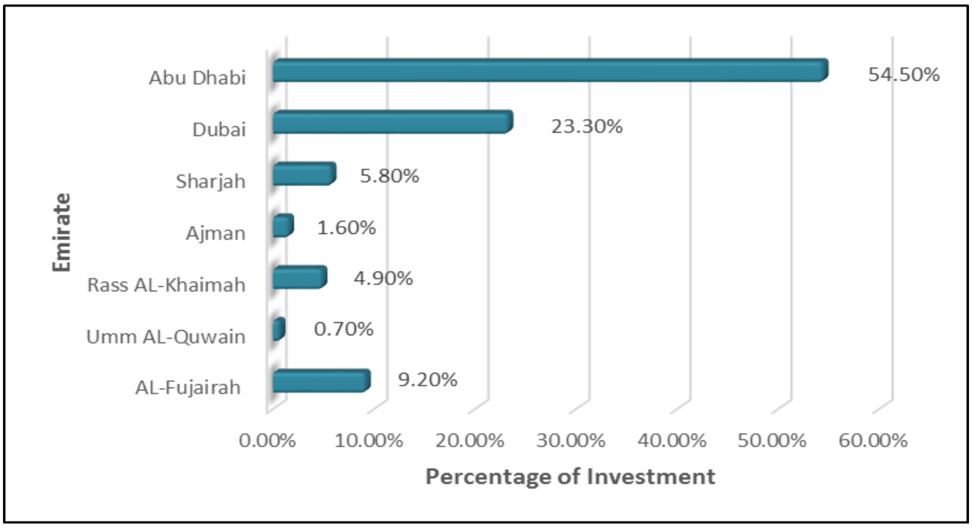


Figure 2.4: UAE Projects Supported by the Emirates

Source: MEED Insight (2015)

Figure 2.5: UAE Construction Industry Outlook

Source: Bank Audi (2015)

Figure 2.4 illustrates that the UAE government is investing in building development largely in the Abu Dhabi and Dubai regions (MEED Insight, 2015). This is not surprising, given the investment and preparation for Expo 2020 in Dubai. Figure 2.5 highlights the increasing investment in building development projects in relation to GDP. Investment in building development projects in terms of GDP was around 10.6% in 2009, but is projected to increase to 11.2% and 11.7% in 2018 and 2021 respectively (Bank Audi, 2015). Because construction in the UAE is expected to grow in order to meet these building development demands, there is a need for research into how risk management is currently undertaken. This is particularly important as the construction industry of the UAE has faced difficulties, especially in recent years. The economic and cultural aspects of the country will be considered in more detail in

Sections 2.13 and 2.14 to further validate the selection of the UAE as a suitable case study for this thesis.

2.4 Projects and Project Management

The PMI (2013, p. 179) define a project as "*a temporary endeavour undertaken to create a unique product, service, or result*"; that is, not a routine operation that has been carried out in the past and will continue indefinitely into the future. Designing a new product or building a shopping mall would be projects: they would have start and finish dates and may never exactly be repeated. Producing a new product or maintaining the shopping mall, however, would be repetitive operations that would continue as long as they made economic sense and so are not considered projects.

To carry out a project, clear objectives must be set and the necessary human, material and financial resources must be identified, obtained and organised with certain constraints of time and cost (Atkinson, 1999; Atkinson *et al.*, 2006; Chapman &Ward, 2003a; Elfaki *et al.*, 2014; Koleczko, 2012; Kutsch & Hall, 2010; Serrador & Turner, 2015; Shenhar *et al*., 2001; Papke-Shields & Boyer-Wright, 2017). PMI (2013) defines project management as "*the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements"* (p. 179).

Project management requires specifying not only the time, cost and scope of the project, but also the quality (specifications) and the risks. It involves managing each of these factors and the interactions between them. In addition to this, a project usually takes place within a particular organisational context, often along with other projects and it may influence and be influenced by this environment.

A number of professional bodies and national associations aim to promote and improve project management around the world. These include:

- The International Project Management Association (IPMA): a non-profit organisation dedicated to developing the project management profession. To this end, it provides standards and guidelines (IPMA, 2013).
- The Project Management Institute (PMI): a US-based non-profit organisation that aims to advance project management. It publishes project management standards in *The Project Management Body of Knowledge* (PMBOK) (PMI, 2013).
- The Association for Project Management (APM): a United Kingdom-based

organisation that aims to promote the science of project management (APM, 2013).

The United Kingdom (UK) government has developed a standard project management methodology for public projects called PRINCE2 (Projects in Controlled Environments, version 2) (PRINCE2, 2009). Other standards for improving project management have been developed by GAPPS (Global Alliance for Project Performance Standards), which makes its information available free of charge (GAPPS, 2015).

There are also standards for specific types of project. For example, the Chartered Institute of Building (CIOB) provides standards for building and construction project management (CIOB, 2017). This is also the purpose of *The Construction Extension to the PMBOK Guide*, published by PMI in 2003. As explained in the PMBOK (2000) Guide (2000) Edition (cited in *Construction Extension*, 2003), "*application area extensions are necessary when there are generally accepted knowledge and practices for a category of projects in one application area that are not generally accepted across the full range of project types in most application areas"* (p. 3).

Each of these professional bodies provide standards and guidelines for managing projects and the present frameworks related to different aspects of projects. One of the main aims of these standards and guidelines is to minimise risk. Risk is one of these elements which is the focus of this research and a discussion of risk can be found in the PMI's *A Guide to the Project Management Body of Knowledge*, published by PMI in 2004, 2008, 2013 and 2017. The concept of risk will be discussed in detail later in this chapter.

In discussing the project management process, it is important not to confuse the project life cycle with the product life cycle. The project life cycle is "*the series of phases that a project passes through from its initiation to its closure*" (PMI, 2013, p. 38), while the product life cycle is the length of time beginning with a product's market launch and ending with its withdrawal from the market. The product life cycle has four stages: introduction, growth, maturity and decline (Altunel, 2017).

For project management, dividing the project life cycle into phases from the project's beginning to its end can improve management control (Altunel, 2017). No single division is ideally suited to all projects, but a typical set of phases includes conceptual/feasibility, planning, designing, executing and finishing (Babatunde & Perera, 2017; Chapman & Ward, 2003a, 2003b). In the conceptual phase, one is still working with preliminary information; more complete information will become available as the project progresses. It follows that the objective in this initial phase is a strategic plan, which will later be refined into a more precise plan as more information becomes available. It is necessary to check plans regularly in any case, as there are bound to be changes in any project (Chapman, 2006; Erdogan *et al.*, 2017).

Larson and Gray (2011) identify four stages of the project life cycle as follows:

- Defining stage
- Planning stage
- Executing stage
- Closing stage

They combined the monitoring and controlling stage with the executing stage, while PMBOK (2004) and Office of Information and Technology (OIT) (2005) kept it separate, resulting in a five-stage project life cycle:

- Initiation
- Planning and design
- Execution
- Monitoring and controlling
- Closing

Figure 2.6 illustrates the construction project life cycle phases.

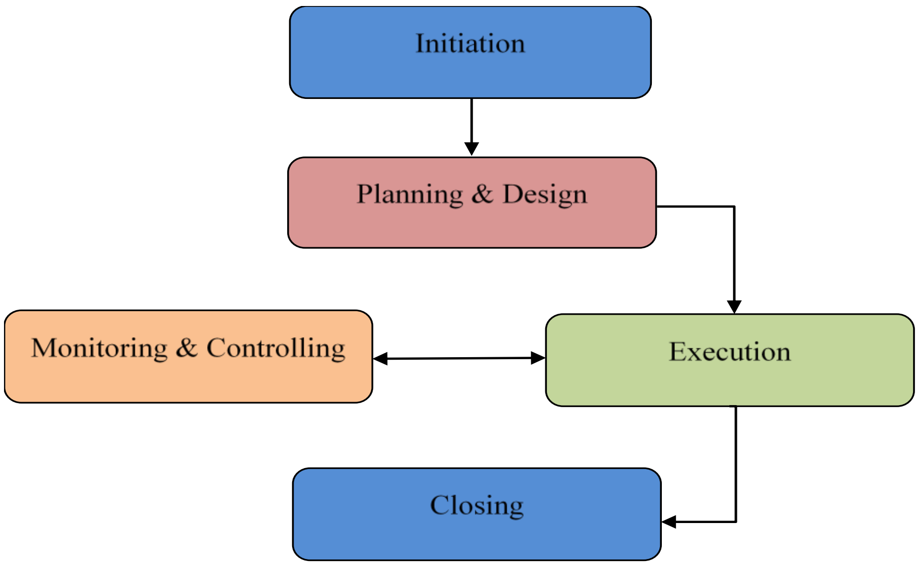


Figure 2.6: Construction Project Life Cycle

Sources: OIT (2005); PMBOK (2004)

Each of these stages is described below.

- *Initiation:* The initial scope of the project is established in the initiation stage. This involves understanding the environment in which the project will be carried out and the resources that will be needed. The preliminary scope statement should also present an organised plan that includes contracting, equipment, budget requirements, costs, tasks and schedule (PMBOK, 2004).
- *Planning and design:* This is the stage in which groups of activities are defined as tasks and their sequences and the required resources are determined. The point is to make clear how the project will be managed during the subsequent executing, monitoring and controlling phases. It should also be made clear how the project will accomplish the end-user's wishes and that this can be done within the time and budget constraints (PMBOK, 2004).
- *Execution:* The activities which have been set out in the project management plan (PMP) during the previous phases are carried out in the execution phase. This requires the project manager to coordinate all the people and resources involved and to integrate their activities successfully, so that the final results set out in the PMP are achieved (PMBOK, 2004).
- *Monitoring and controlling*: In this stage, it is necessary to keep track of the project execution in order to identify problems and correct them. The monitoring and controlling aspects apply not only to the project's activities, but also to the actual cost, time and effort in comparison with what was projected in the PMP. Finally, it is necessary to monitor the project performance baseline, which involves addressing risks and taking the appropriate actions (PMBOK, 2004).
- *Closing*: In the closing stage, the project manager turns the construction project over to the end-user. In the project closure stage, all project activities are finalised. Then, in the contract closure stage, all project-related contracts are formally completed and closed (PMBOK, 2004).

There are many types of projects and each type needs to be managed differently. The next section explores one particular type: the construction project.

2.5 Construction Projects

Construction projects create physical infrastructures such as civil construction, residential buildings, industrial and commercial buildings, highways and utilities. The phases or stages of a construction project are much like those of other types of project. Various individual and institutional authors' have divided up the construction project life cycle in various ways. For Al-Sabah *et al.* (2014), Baghdadi and Kishk (2015), El-Sayegh (2008); El-Sayegh and Mansour (2015), Hanna *et al*. (2013), Zou *et al*. (2006, 2010) and Chapman and Ward (2004), the phases are feasibility, design, construction, and operation. For Akinsanya and Idowu (2015), Salah and Moselhi (2016) and Liu and Zhu (2007), they are conceptual, design, tender, preconstruction, and build; and for PMI (Construction Extension) (2003), they are concept, planning (and development), detailed design, construction, and start-up and turnover. These divisions are fairly similar and sometimes scholars just use different names for the same phase. Others may subdivide a phase into two phases in order to devote more careful attention to each (e.g., Lester, 2017a; Nasirzadeh *et al.,* 2016).

Any construction project is likely to start with a feasibility phase. The goal of this phase is to determine whether the project is 'really' possible and deliver a 'go/no-go' decision. There can be iterations of the feasibility phase if it becomes necessary to alter the project before deciding to go ahead with it. If the project is deemed possible, this decision will be followed by planning and then by designing the project in adherence to its specifications. Then comes the phase of building the project—the actual construction. Tendering, preconstruction and handover phases may be added to this outline, but the overall project life cycle remains the same (Lester, 2017a; Ng *et al.,* 2004).

While a construction project may involve any number of parties, the main parties are generally client (employer), contractor and consultant. These three categories may, in turn, include various specialists such as superintendents, project managers, subcontractors, quantity surveyors and technical managers; any of whom may play a part in one phase or another depending on nature of the project, type of procurement system being used, and type of contract adopted (Peckiene *et al.,* 2013; Nasirzadeh *et al.,* 2016).

The three main categories are defined as follows:

- *Client:* A responsible legal person who signs the construction contract and assigns its activities to contractors in accordance with the contract's documents. Clients invest in and fund construction projects. The client's objective is to have the project delivered on time and within budget and fit for purpose;
- *Contractor:* A responsible legal person who, by signing the construction contract, takes

responsibility for construction activities. Contractors undertake the work of constructing a building or any other type of construction. The contractor's objective performing under the contract is to make a profit; and

- *Consultant:* A responsible legal person introduced to the contractor by the client in order to supervise the execution of the work with whatever authority is granted in the contract. Consultants are hired to use their professional skills and experience to protect the client's interests. They advise the client on most aspects of the project, including design, budget and contracts. They must also manage their own risks and protect themselves from disputes or lawsuits due to defective advice or work (Ghahramanzadeh, 2013; Nasirzadeh *et al*., 2016).

Love *et al*. (1998) define a procurement system (delivery system) as "*an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the various elements in the construction of a project*" (p. 229). With any new project, the client tries to set up a procurement system that will fit the project's objectives. The specifications of the procurement system will affect the project's time, cost and quality.

Ashworth and Hogg (2007) and Safa *et al.* (2017) define a construction procurement system as the management of the entire project and it is thus associated with the delivery of the project. Different procurement systems vary in the way they allocate responsibilities, the order in which they sequence the activities, the organisational approach they adopt, and the processes that they use in order to deliver the project. For this reason, the procurement system varies from one project to another and clients may use different procurement systems for different aspects of the project. Morledge and Smith (2013) argue that a construction project's procurement system is mainly concerned with how people interact with each other and with their environment. That is, it takes into account the project's human aspect as well as its social, cultural and ethical aspects.

Much depends, then, on how a project's responsibilities and risks are allocated to various parties through various procurement systems and how these various parties then cooperate. Procurement systems are classified into four main types: traditional, design and build, management contracting and construction management. These are discussed below.

- *Traditional:* These have three phases: design, bid and build. After the client initiates the project, the consultant designs it and then the contractor bids to carry out the actual construction.

- *Design and build:* In this type of procurement system, the contractor carries out both the design and the construction phases.
- *Management contracting:* In this system, the work is carried out by a group of subcontractors chosen through competitive bidding who are under contract to the main contractor (known as the management contractor).
- *Construction management:* Here, the project's planning, design and construction phases are carried out in an integrated fashion with the client, consultant and contractor working in unison (Al Mousli & El-Sayegh, 2016; De Araujo *et al*., 2017; Naoum & Egbu, 2015; Oladinrin *et al*., 2013; Pal *et al*., 2017; Yusof *et al.*, 2016).

There are other types of procurement systems, including public-private partnership (PPPs), cost-led supply chain contracts, alliance contracts and private finance initiatives (PFIs), in which government and private sector companies cooperate on a project. An important process in any construction procurement system is the process for selecting the best type of contract given the particular project and its size and objectives. One of the main reasons for choosing a specific type of procurement system or a specific type of contract is the way it allocates responsibility to the various parties; in particular, how it allocates risk (Arndt, 1998; Beyene, 2014; Bing *et al.,* 2005; Davis *et al*., 2008; Geraldi & Albrecht, 2007; Ghahramanzadeh, 2013; Obicci, 2017; Sastoque *et al.,* 2016; Ward *et al.,* 1991). Risk allocation will be discussed in further detail later in the chapter.

Some of the types of contract in use for construction projects are described below.

- *Fixed price/lump sum price:* The contractor charges a fixed price to the client and is responsible for the work set out in the contract.
- *Reimbursable/cost plus:* The client pays contractor an agreed fee or margin.
- *Billed rates/unit rates:* The contractor is paid according to the calculation and assessment of the completed work based on unit rates.
- *Turnkey/design build:* The contractor is responsible for every phase of the project from initial design to completion.
- *Partnership/joint venture:* The project will be carried out by a number of companies working together, which can be due to the project's size or due to political considerations (Antoniou *et al.,* 2012; Ghahramanzadeh, 2013; Borg & Lind, 2014; Hwang *et al.,* 2017; Suprapto *et al.,* 2016).

Section 2.8 will discuss how a client uses the procurement system and the contract to allocate project risk to the various parties involved and how the risk is shared between them.

The client's allocation of responsibility and risk through their choice of procurement system and contract are 'very' important for ensuring appropriate project management. Reports by the UK's Public Accounts Committee (PAC) and National Audit Office (NAO) include examples of how a number of projects were managed and the factors that affected them through their life cycles. For example, an NAO report (2009) attributes the failure of Metronet, which was associated with the London Underground project in 2007 through a public-private partnership in London, to "*its poor corporate governance and leadership*" (p. 9). Repeated changes in the executive management combined with various political issues left it unable to manage efficiently or to acquire high-quality information. In this case, the choice of public-private partnership as the project's procurement system and the way in which the parties cooperated throughout the project affected how the project was managed.

The 2012 London Olympic and Paralympic Games offer another example. By 2007, the budget had almost quadrupled from 2.4 billion pounds to about 9.3 billion pounds. According to PAC (2010), "*one of the main reasons for the increased budget for the Games announced in March 2007 was the inclusion of a funded contingency, but three years later there is still no such contingency for LOCOG* [London Organising Committee of the Olympic and Paralympic Games]" (p. 15). Again, it is possible to see how political, governmental and managerial issues can make the client's plans and cost estimates unrealistic. This, in turn, may require a budget increase that may not be possible to achieve (PAC, 2010). Such was famously the case for Boston's Big Dig (or Central Artery) project. Government officials originally stated that the project would cost \$2.6 billion, but the cost increased sixfold to \$14.6 billion and was completed seven years late (Love *et al.*, 2015).

Examples of how clients and contractors manage construction projects in the UAE and the economic, cultural and managerial influences on any project will be discussed in Chapters 5 and 6.

Thus, the characteristics of each construction project will influence the type of approach that is taken and how the project is managed. Sometimes there are many interdependent activities, each with its own time, cost, quality specifications and risks (Ali *et al.*, 2015; Arditi *et al.*, 2017; De Bakker, Boonstra & Wortman, 2010; Elfaki *et al.*, 2014; Gunhan & Arditi, 2007; Meng, 2012; Serrador & Turner, 2015). The focus of this study is one of those factors, risk, which will be discussed in the next section.

2.6 History of Risk Management

In *Against the Gods: The Remarkable Story of Risk* (1996), Peter L. Bernstein traces the modern quantitative risk management theory back to its origins, from the Hindu-Arabic numbering system, developed over 800 years ago, to the formation of the theory of probability and the rapid rise of quantitative techniques in the Renaissance. The history that Bernstein relates is characterised by a recurring tension between the belief that the highest quality decisions are based on quantification, founded in patterns observed in the past, and the belief that decisions are better based on more subjective views of the uncertain future. Those who are not inclined to accept subjective probabilities tend to see probability and uncertainty as incompatible (Bloom, 2014; Chapman *et al*., 2006).

Until late in the 20th century, rational decision-making models—that is, models based on linear decision-making, with results proportionate to the cause—continued to be prominent. This is despite early critiques from Frank Knight (1921) and John Maynard Keynes (1921), who were not convinced that this approach was correct, given the limitations in human rational decision-making. Psychologists were particularly concerned with the discrepancies between reality and rational decision-making models and vigorously investigated the nature and causes of the deviations they observed, finding them to be quite frequent (Bernstein, 1996).

In the late 1970s and '80s, Daniel Kahneman and Amos Tversky conducted pioneering research on this subject. Their ingenious experiments revealed a phenomenon that had been missing from the theory of rational decision-making: people valued a risky opportunity much more in terms of the reference point against which the possible loss or gain would be measured than in terms of the final value of the gain itself. They found, if a choice is presented as a gain, most people are risk-averse: if the same choice is presented as a loss, most people are risk takers. From these findings, Kahneman and Tversky developed prospect theory, which describes how people make different choices when the same problem is presented in different forms as a failure of invariance. They attributed such patterns of behaviour to emotions, which, in their view, destroyed the self-control necessary for rational decision-making. Emotions, in turn, were seen as related to cognitive difficulties. At the core of this theory is the assertion that people have difficulty sampling and therefore use shortcuts, known as heuristics, which can result in incorrect perceptions (Kahneman & Tversky, 1972; Kahneman, 2003a, 2003b; Phillips & Pohl, 2014; Tversky & Kahneman, 1986, 1974, 1992; Tversky & Fox, 1995). Gigerenzer and Gaissmaier (2011) describe heuristics as *"efficient cognitive processes, conscious or unconscious, that ignore part of the information"* (p. 451).

The ability of risk management to deliver on its claims depends heavily on both individual attitudes and organisational attitudes (Arrow & Lind, 2014; Harvett, 2013; Hellier *et al*., 2001; Johnson & Busemeyer, 2010; Meng & Boyd, 2017; Serpell *et al.,* 2015; Slovic, 1987; Smallman & Smith, 2003). The human element makes the risk process even more complex, both explicitly and covertly. For this reason, individuals, groups, corporations and even countries adopt risk attitudes which then affect all factors of risk management. It is possible to assess and describe such risk attitudes, however, which brings to light the sources of bias and their effects on the risk process (Hillson & Murray-Webster, 2012). Hillson and Murray-Webster's books, *Understanding and Managing Risk Attitude* (2005) and *Managing Group Risk Attitude* (2008) respectively, are less focused on theory and research than on emphasising a pragmatic approach to risk management. (Risk attitude is discussed further in Section 2.11.)

In a paper assessing the previous decade of research on risk management, Zhang (2011) examines the aforementioned continuing tension between quantification and subjectivity in a discussion of two schools of risk management: one of which considers risk to be an objective fact and the other considers it as a subjective construction. The first school asserts that risks objectively exist and are probabilistic in epistemology. Objective risk analysis produces knowledge which comes from rational decision-making. The other school asserts that the phenomenon of risk is subjective and constructed, with multiple epistemological dimensions. A risk analysis cannot therefore be objective and natural; rather, it is value-rich (Zhang, 2011).

In the real world, there seem to be ever more discontinuities, irregularities and volatilities rather than fewer. In Bernstein's (1996) view, the progress of civilisation has accorded less importance to nature's unpredictable ways and more to human decisions. The author believes that, while many tools have been developed to deal with risk, there is still much that is unresolved. *Against the Gods* concludes with a discussion of chaos theory, "*emphasising its potential contribution to the risk management discipline, due to the theory's preference towards non-linear thinking, in which results are not proportionate to their causes*" (p. 262). The concept of risk is discussed further in the following section.

2.7 Definition of Risk

In order to manage uncertainty and risk, it is necessary to first define them (Alessandri *et al.,* 2004; Atkinson *et al*., 2006; Aven, 2016; Cooper *et al*., 2014; Giang, 2015; Harvett, 2013;

Kahneman & Tversky, 1979; Koleczko, 2012; Olsson, 2007; Sanderson, 2012; Walker *et al.*,2017; Winch & Maytorena, 2011; Ziyu *et al.*, 2017). Differing definitions have led to misunderstandings and have undermined decision-making (Sanderson, 2012). The inadequacy of risk management processes (defined in Section 2.10) to manage risk in construction projects will be discussed in more detail in Section 2.8, with reference to the potential value of project success (defined in Section 2.15) concepts in managing risk in such environments.

The literature continues to disagree about the definitions of uncertainty and risk. A risk management process cannot be carried out without an interpretation of risk; however, this definition will be different for varying applications and contexts. In particular, the various components of the term 'risk' must be clarified in order to understand risk in construction projects.

Bernstein (1996) points out that the word risk comes from the Italian verb *riscare*, meaning 'to dare' or 'to have the cheek to do something', which is to say that risk is not a fate but a choice. Any choice one makes in life involves risk, which is the result of uncertainty, which is itself the result of a lack of information, knowledge or experience (Muriana & Vizzini, 2017; Jannadi & Almishari, 2003). Since the study of risk began during the Renaissance, various definitions have been put forth, some of which will be discussed below. But, before addressing that further, three terms which are frequently used in discussions of risk which are sometimes used interchangeably first need to be defined: uncertainty, hazard and vulnerability.

Ambiguity and volatility are key factors of uncertainty (Alessandri *et al.,* 2004; Bell, 1985; Carson *et al*., 2006; Harvett, 2013; Lenfle, 2011; Ramasesh & Browning, 2014; Smithson, 2015; Song *et al.,* 2007; Walker *et al*., 2017). Ambiguity can be defined as the lack of transparent data about external parameters and uncertainty concerning cause-effect interactions and methods or practices and their perceived impacts. Volatility can be defined as the unpredictable effects that the environment can produce or the unpredictable rate at which it can change. Volatility continually causes uncertainty concerning unknown or future events (Bell, 1985; Carson *et al*., 2006; Harvett, 2013; Lenfle, 2011; Ramasesh & Browning, 2014; Smithson, 2015; Song *et al.,* 2007; Walker *et al*., 2017).

Variability is the possibility of many different values for a single quantifiable parameter. It is another element of uncertainty (Chapman & Ward, 2003b; Smithson, 2015; Song *et al.*, 2007). Rolling a six-sided die, for example, can only produce a single result. Variable uncertainty within a range of foreseeable outcomes (in this case, 1 through 6) is known as aleatoric uncertainty. The exact result of the throw cannot be known before it happens, but the set of possibilities is precisely known (Blackman & Featherstone, 2015; Hillson, 2004a, 2004b; Olsson, 2007). In contrast, ambiguity is the unquantifiable measure of uncertainty, where uncertainty refers to an associated meaning (Backus *et al.,* 2015; Bloom, 2014; Kaplow & Weisbach, 2011; Walker *et al*., 2017). The difficulty is not in calculating the probability of a particular result of an event, but rather that the event itself lacks transparency. One not only does not know what *will* happen, as with dice, but also does not entirely know what *could* happen. Such uncertainty is known as epistemic uncertainty; referring to vague or partial knowledge about a phenomenon, which in turn is often due to poor communication. It is in the early stages of a project's life cycle that is easiest to identify ambiguity and variability (Atkinson *et al*., 2006; Harvett, 2013; Pushkarskaya *et al*., 2015; Walker *et al*., 2017; Wu *et al*., 2017).

Flanagan and Norman (1993) define uncertainty as "*a situation in which there are no historic data or previous history relating to the situation being considered by a decision maker*" (p. 46). With risk, too, the future is unknown, but the decision-maker has information and historical data with which to assess an event's probability. In short, while there can be no risk without uncertainty because there is always uncertainty, it is possible to estimate (whether rationally or intuitively) an event's probability for risk but not for uncertainty.

According to Harvett (2013) and Winch and Maytorena's (2011) rethinking of project risk management from first principles, the concepts of uncertainty and risk differ fundamentally due to the difference between *a priori* statistical probabilities and estimates. Risk, in their view, is a matter of logical, quantitative analysis, while uncertainty is a matter of judgement and intuition. Perminova *et al*. (2008) views risk as an implication of project uncertainty and they define uncertainty as "*a context for events having a negative impact on the project's outcomes or opportunities, as events that have a beneficial impact on project performance*" (p. 76). Backus *et al*. (2015), Harvett (2013) and Hillson and Murray-Webster (2004, 2005, 2011, 2012) distinguish uncertainty from risk in terms of the consequences: an uncertainty that does not have consequences does not create risk. It follows that risk must be defined in relation to objectives and its consequences for those objectives; that is, as *"an uncertainty that could have a positive or negative effect on one or more objectives"* (Hillson and Murray-Webster (2012, p. 254).

The term 'hazard' is defined by the UK Health and Safety Commission (1995) as "*the potential to cause harm."* Given some probability that one may be exposed to a hazard, the loss that would result if that hazard occurred is termed vulnerability (Brimicombe, 2003; Ghahramanzadeh, 2013; Walker *et al.*, 2017). Hazard and the resulting vulnerability are therefore thought of as components of risk.

Uncertainty avoidance, one of Hofstede *et al.*'s (2010) four dimensions of culture (discussed in Section 2.2.2), can also be seen as a component of risk. The left side of Figure 2.7 shows that the UAE scores 68 on the UAI, meaning that its citizens strongly prefer to avoid uncertainty. Countries that score highly in uncertainty avoidance are characterised by rigid rules and codes of belief and may oppose innovation. This is how such a society copes with the fact that the future is unknown, which members of that society consider threatening (Walker *et al.*, 2017).

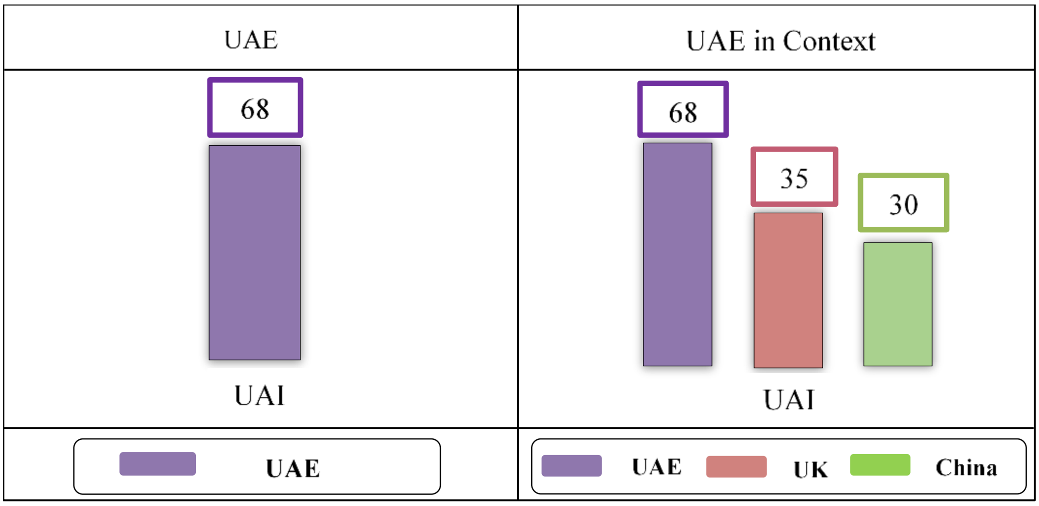


Figure 2.7: UAI of UAE and in Comparison with China and the UK Scores

Source: Based on the Hofstede Centre (2013)

The right side of Figure 2.7 compares the UAE with the UK and China, whose uncertainty avoidance scores of 35 and 30 respectively are much lower. Members of these societies may be more flexible about the rules, depending on the particular situation, and are more at ease with ambiguity and the fact that one never really knows what will happen next (Hofstede Centre, 2013). It is possible to see, then, that the risk management strategies used in one country cannot be expected to have the same results in a different country where people have a different acceptance of risk and different ways of dealing with the uncertainties of life.

It is important to note here that, given the focus of this thesis is risk, uncertainty, hazard, vulnerability and uncertainty avoidance are all to be seen as components of risk but are not be confused with risk itself. Looking at how the definition of risk has been expanded in recent years through changes in definitions clarifies this issue. In 2004, the Australian/New Zealand

Standard for Risk Management (AS/NZS 4360, 2004) defined risk as *"the possibility of something happening that impacts on your objectives. It is the chance to either make a gain or a loss. It is measured in terms of likelihood and consequence"* (p. 76). In 2009, however, the revised International Standard for Risk Management (known as ISO 31000) defined risk simply as *"the effect of uncertainty on objectives."*

Dickinson (2001) took a similar approach, defining 'enterprise risk' as "*the extent to which the outcomes from the corporate strategy of an organisation may differ from those specified in its corporate objectives, or the extent to which they fail to meet these objectives*" (p. 361). For Harvett (2013), risk is "a phenomenon objectively correlated with subjective uncertainty of an undesirable event occurring" (p. 39). For Loosemore *et al*. (2006), it *is "a potential future event which is uncertain in likelihood and consequence and, if it occurs, could affect a company's ability to achieve its project objectives"* (p. 10). Both Harvett (2013) and Loosemore *et al.* (2006) present risk as something unwanted. But for Rutherford (2002), however, risk is "*an outcome which can be calculated through measuring probabilities*" (p. 182): a factor that is not inherently positive or negative. Similarly, PMI (2013) defines risk as "*an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality*" (p. 46).

These effects would be referred to as 'threats' if they were negative and as 'opportunities' if they were positive (Ghahramanzadeh, 2013; Figueiredo & Kitson, 2009; Fontaine, 2016; Muriana & Vizzini, 2017). In this thesis, the definition of risk presented by PMI (2013) will be adopted for risk as it makes explicit reference to projects. This will be consistent with the conducted modelling (discussed in Chapter 5) in which the considered risks and risk factors might have either positive or negative impact on project success.

As discussed above, all choice includes risk and executing a project is a choice. Chapman (1997) and Walker *et al*. (2017) agree that all projects carry risk and that it is therefore pointless to aim to carry out a zero-risk project. A construction project, like any project, carries risk because there is significant uncertainty about what level of performance can be achieved. Therefore, the concept of risk in construction projects is discussed further below.

2.8 Risk in Construction Projects

Akintoye and Macleod (1997) define construction risk as "*a variable in the process of a construction project whose variation results in uncertainty as to the final cost, duration and quality of the project*" (pp. 198–203). As discussed in Section 2.5, construction projects are those that create physical infrastructure such as civil construction, industrial and commercial buildings, residential buildings, highways and utilities.

Construction is both project-based and multi-organisational, making it one of the most risky, difficult and dynamic industries (Ghahramanzadeh, 2013; Hanna *et al.,* 2013; Hwang *et al.,* 2017; Iqbal *et al.,* 2015; Liu *et al.,* 2016; Lyons & Skitmore, 2004; Mills, 2001; Sambasivan *et al.,* 2017; Serpella *et al.,* 2014; Zhi, 1995). Due to construction's financial intensity, complex procedures, long project durations, risky environment and dynamic arrangements of participating organisations, it involves many different risks and they differ from one construction project to another (Panthi *et al*., 2009). Aside from the risks just mentioned, there are also risks from the market situation, the level of competition, the size of the project, the expertise of the parties involved and the political, economic and cultural variations (Akintoye & Macleod, 1997; Al-Hajj & Sayers, 2014; Al Harthi, 2015; Altoryman, 2014; Al Mousli & El-Sayegh, 2016; Flanagan & Norman, 1993; Smith, 2008; PMI, 2004; Smith *et al*., 2009).

There are risks in every phase of the project life cycle and some risks may be present in more than one phase. Scholars disagree about the level of risk in the various phases of a construction project. For Chapman (1997), Godfrey (1996), Hayes *et al*. (1986), Harvett (2013), Hassanein and Afify (2007) and Salah and Moselhi (2016), the greatest risk is at the beginning, when there is the least information about the project and therefore the greatest uncertainty. For De Araujo *et al*. (2017), Lester (2017a) and Zou *et al*. (2006, 2007), however, the construction delivery phase is even more risky than the feasibility (conceptual) phase. Still, other theorists are convinced that construction risk increases from one phase of the project life cycle to the next (Al-Sabah *et al.,* 2014; Baghdadi & Kishk, 2015; Wang *et al*., 2004).

However, when the project is most risky depends 'very' much on the risk's overall effect on the project's objectives. Chapman (1997), Safa *et al.* (2017) and Salah and Moselhi (2016) argue that the risk is highest in the early stages because this is the stage in which it is most possible to make a fundamental 'mistake' that cannot later be corrected. In the early stages, the decisions that call for risk management are strategic decisions, which means they have significant consequences for the project's objectives, but in the later stages, they are more likely to be tactical decisions that have less drastic consequences.

A number of authors and institutes have categorised construction risks into various types and hierarchies. Akintoye and Macleod (1997), Al Harthi (2015), Baghdadi and Kishk (2015), Dziadosz and Rejment (2015), Flanagan and Norman (1993) and Khodeir and Mohamed

(2015), for example, propose a broad division into (a) pure/static risks, which offer possible losses but no possible gains, and (b) dynamic/speculative risks, which offer possible gains as well as possible losses.

Taking a different approach, Al Mousli and El-Sayegh, (2016), El-Sayegh and Mansour (2015) and Smith and Bohn (1999) divide risks into the internal and the external. Internal risk is generated inside the project and is, therefore, more likely to be controllable. External risk is generated outside the project and its likelihood is probably not controllable, but it may be possible to have some influence over the consequences.

Forteza *et al*. (2017) and Smallman (1999) suggest a classification into (a) direct risks, which include human, organisation and technological (HOT) risks, and (b) indirect risks, which include regulatory, infrastructural and political (RIP) risks. What the classification of risk into direct and indirect and the classification into internal and external have in common is that they both take into account the extent to which a risk is project-specific.

Risk has also been divided into (a) subjective risk, which can be assessed on the basis the analyst's qualitative knowledge and experience, and (b) objective risk, which can be assessed by quantitative calculation of the likelihood and impact. According to Adams (2008) and Ghahramanzadeh (2013), most of the risk in a construction project is 'subjective', due to the lack of historical data for quantitative analysis. Analysis of such risks should therefore be a matter of judgement.

Risks can also be categorised by type and impact. Al Mousli and El-Sayegh, (2016), El-Sayegh and Mansour (2015), Fernando *et al*. (2017) and Wiguna and Scott (2006) propose five categories: economic and financial risks, cultural diversity, external and site condition risks, technical and contractual risks and managerial risks. The PMI (2004) proposes a different set of four categories: technical risks, organisational risks, project risks and external risks and the four are referred to collectively as TOPE risks. As discussed earlier, there are similarities amongst the different classifications. Both the examples just given include technical risks and external risks amongst their four categories. Section 2.12 will further discuss the classification of construction risks.

Risk of any type needs to be managed in order to avoid or mitigate the negative outcomes and to recognise the opportunities as 'quickly as possible' in order to gain the maximum benefit from them. When a construction project begins, all risk is the client's risk. As explained in Section 2.5, choosing a procurement system and a contract allocates some of that risk to other parties (Safa *et al*., 2017). A traditional procurement system, with the parties sharing the responsibilities for the project's various phases, is meant to balance the risk amongst those parties. A design-and-build system allocates most of the risks to the contractor, who contracts to take responsibility for both the design and the construction stages. With management contracting and construction management procurement systems, the contractor mainly provides management expertise rather than execution, which leaves a lot of risk in the hands of the client (Aje *et al.,* 2016; Davis *et al*., 2008; Hwang *et al.*, 2014; Kangari,1995; Oladinrin *et al*., 2013; Osipova & Eriksson, 2011; Shen *et al*., 2006; Ziyu *et al*., 2017).

Given a chosen procurement system, however, the type of contract will also determine what portion of the risk is assumed by the parties involved. With a fixed price contract, the contractor takes responsibility for most of the execution and therefore takes on most of the risk. With a reimbursable contract, the contractor is paid a percentage of the cost of the project and may therefore try to maximise the cost in order to maximise the profit. This leaves the client taking most of the risk; in particular, the financial risk. With billed rates and turnkey contracts, the contractor assumes most of the risk because they are responsible for executing most of the phases of the project. With partnership contracts, there needs to be a balance between the parties in the assumption of the project risk (Ghahramanzadeh, 2013; Hwang *et al.,* 2017; Salawu & Abdullah, 2015).

However, the total project risk is divided up; it is essential that the risks be managed systematically. Risk management, which is an essential part of project management, is therefore discussed in the next section.

2.9 Risk Management

Any project has inherent uncertainty and risk because, by definition, each project has unique characteristics and there are likely to be changes and problems as the project is undertaken. Such risks, which can include dependency on the environment and the complexities of any multi-organisational effort, are inherently difficult to handle, which is why it is so important that risk management be an integral part of project management (Alessandri *et al.,* 2004; Chandra, 2015; Cooper *et al*., 2014; Flyvbjerg *et al.,* 2003; Ward, 1999; Zou *et al*., 2007; Szymanski, 2017). The purpose of project risk management is to help people make decisions which will improve the project's performance and make sure it achieves its objectives (Loosemore *et al*., 2006; Wibowo & Taufik, 2017). Although it can be difficult to find the right techniques with which to identify and manage a project's risks, even more difficult is to acknowledge the uncertainty of life and then be willing to grapple with that uncertainty rather than ignoring it (Rohaninejad & Bagherpour, 2013).

Risk is a part of any decision-making process (Chandra, 2015; James *et al.,* 2006; Skorupka, 2008; Ziyu *et al*., 2017). While the tools and techniques of risk management can be useful, it is not the tools but the individual person, with his or her particular risk appetite, who makes the decision. This decision will always have a subjective component, which is the individual's view and interpretation of the situation, and an objective component, which is the facts about the probability of whatever gains and losses may follow from the decision. Since the illusion of certainty is undoubtedly a significant cause of bad decisions, as much relevant information as possible should be brought to bear on making any decision (Hwang *et al*., 2017; Flanagan & Norman, 1993).

Just as a project benefits from a project manager who has the necessary qualifications, skills, knowledge and expertise, it will also benefit from a risk manager's specific expertise in managing risk systematically. The larger and more complex the project, the more important it is to delegate specific responsibilities to people with expertise: a project's risks call for dedicated risk managers. Project management guides and standards use the term 'risk owner' for this role. PRINCE2 (2009) defines a risk owner as *"a named individual who is responsible for the management, monitoring, and control of all aspects of a particular risk assigned to them, including the implementation of the selected responses to address the threats or to maximise the opportunities"* (p. 153). Most people involved in management use the term 'risk manager' based on their understanding of a 'manager' as someone who is responsible for some portion of the work. For this reason, the term 'risk manager' is used in the questionnaires and interviews conducted in this study (in order to prevent any confusion for participants).

Uher (2003) defines risk management as "*a systematic way of looking at areas of risk and consciously determining how each should be treated. It is a management tool that aims at identifying sources of risk and uncertainty, determining their impact, and developing appropriate management responses*" (p. 18). The risk management process can be divided into the following activities: risk identification, risk analysis and risk response and monitoring and control. Risk response can be subdivided into avoidance, reduction, retention and transfer (Al Harthi, 2015; Berkeley *et al*., 1991; Chapman, 2006; De Oliveira *et al*., 2017; Dziadosz & Rejment, 2015; Flanagan and Norman, 1993; Harvett, 2013; IPMA, 2013; ISO 31000, 2009; PMI, 2008, 2015; PRINCE2, 2009; Uher & Zantis, 2011). Other divisions of the risk management process and the risk response process may differ from other people's viewpoints and this aspect will be discussed in Section 2.10.

Since a project's environment and prerequisites can keep changing, risk management needs to be an ongoing part of the project life cycle (PLC). In the view of Babatunde and Perera (2017), Chapman (1997), Erdogan *et al.* (2017) and Lester (2017a), risk management should be integrated into the entire project management process beginning in the planning phase as an 'add-in' process, not as an 'add-on'. This contrasts, however, with the discussion earlier in this chapter about the risks and phases of a construction project. Typically, the planning phase is preceded by a feasibility phase, considered a particularly risky phase for any construction project. This is the phase in which the 'go/no-go' decision must be made. That being the case, the risk management process (RMP) needs to extend even to the feasibility phase if it is to effectively manage the risks of a new project. In particular, the RMP is what may produce a no-go decision, saving everyone involved from an expensive failure.

As described by Brown and Chong (2000), De Oliveira *et al.* (2017) Ghahramanzadeh (2013), Hastak *et al*. (1994) and Skorupka (2003), risk management is a collection of techniques for identifying, analysing and then avoiding or minimising the problems that are bound to occur during the PLC, all with the ultimate aim of carrying out the project's objectives. Flanagan and Norman (1993), Khodeir and Mohamed (2015) and Zwikael and Ahn (2011) hold a similar view, seeing risk management as a discipline for living with the constant possibility of something going wrong.

Both of these definitions of risk management focus on negative effects: the 'disturbances' and 'adverse effects' which must be 'mitigated'. The same can be said of the Project Risk Analysis and Management (PRAM) guide presented by the Association for Project Management (APM) (2013), which is concerned with how risk management at the project level is connected with risk management at the corporate level. This study defines the risk management process as '*a process designed to remove or reduce the risks which threaten the achievement of project objectives*' (APM, 2013, p. 27). In contrast to all of these, the PMI sees risk as being potentially either positive or negative, which is the meaning used in this thesis. From this, it follows that risk management must be a process for managing both the positive and negative outcomes of risk. That is the view taken in this thesis, which uses the PRINCE2 (2009) definition of risk management as "*the systematic application of procedures to the tasks of identifying and assessing risks, and then planning and implementing risk responses"* (p. 176). Seen this way, risk management can do more than just help make sure the project is completed on time and within budget. Its other possible benefits include:

- Contributing to a less subjective and more systematic decision-making process;
- Showing the significance of various risks, reducing their losses and increasing their opportunities;
- Helping management understand the project better by identifying its risks and considering how to manage them; and
- Improving communication.

Other associations have their own guidelines for a formalised risk management process that allows for both positive and negative risk. For example, the ISO 31000:2009, published by the International Organization for Standardization (2013), defines risk management as providing "*principles, frameworks and a process for managing risk*" (p. 31). Along with this standard, there are related standards offering more detailed information on the risk management process; these include ISO Guide 73:2009, which has definitions related to risk management, and ISO/IEC 31010:2009, which concentrates on techniques for risk assessment. An important change in ISO 31000 is its conceptualisation of risk as 'the effect of uncertainty on objectives'; that is, as an effect which could be negative or positive rather than strictly as the possibility of loss.

The risk management framework in this standard offers universal principles for identifying, analysing, evaluating and responding to both opportunities and threats. The ISO 31000 is not for a specific industry. Its risk management process begins by establishing the context: the organisation's objectives, environment and stakeholders. In this way, the organisation can identify its risks and create a risk management framework that is aligned with its stakeholders' objectives, strategy, values and risk attitude (discussed later in Section 2.11) (ISO 31000, 2009). In a broad sense, this formal risk management process has been adopted by enterprise risk management (ERM) organisations (COSO, 2004).

ERM is defined by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) (2004, p. 34) as "*a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives*." The objective of ERM is to figure out how much risk an organisation should take on in order to increase value for its stakeholders. COSO ERM-Integrated framework is designed to manage the risks related to an organisation's objectives in light of its risk appetite and that of its stakeholders. The parties in any construction project would therefore assess its risks and determine whether or not they are acceptable.

Although no risk management process can render a project risk-free, it can help management accept the right risks and manage them effectively and should therefore be part of any construction project. It creates an organised decision-making framework, in part by continuously providing management with the best available information, including information on factors which can affect risk and on possible strategies and options (Safa *et al.,* 2017). It is worth repeating that risk management should not be a one-time activity, but rather a continuous activity from the very beginning of the project to its conclusion (Hwang *et al.,* 2017; Iqbal *et al.,* 2015; Liu *et al*., 2016; Sambasivan *et al.,* 2017; Wiegelmann, 2012).

2.10 Risk Management Processes

Most construction projects end up with cost and/or time overruns. Adam *et al.* (2017) report that a study of 258 public works projects in Europe and North America found that around 86% had cost overruns, boosting the actual cost 28% over the estimated cost. One common cause was inappropriate risk analysis: in the early stage of the project, the scope of work was inaccurately assessed as the budget was being developed. The other main cause was political pressure which forced the project to be delayed because of legal action, skills shortage, site problem, natural events or to serve political agendas.

A risk management process includes organisational rules and procedures for (a) identifying, analysing, responding to and controlling potential risks, and (b) monitoring and controlling the efficiency and profitability of the organisation's risk management activities. The risk management process is subject to wide variation and may mean different things to different people in the organisation. Risk management operations may therefore be fragmented and suffer from lack of high-level visibility and overview (Chin & Hamid, 2015; Cooper *et al*., 2014; Cretu *et al.,* 2011; De Oliveira *et al.,* 2017).

Unsurprisingly, there has been a variety of schemes dividing the risk management process into sub-processes. Berkeley *et al.* (1991), De Oliveira *et al.* (2017); Dziadosz and Rejment (2015), Flanagan and Norman (1993), Leitch (2010) and Olechowski *et al.* (2016) categorise the risk management process into risk identification, risk classification, risk analysis and risk response. Chapman (1997), Thamhain (2013) and Wang *et al.* (2016) propose a more detailed division: define, focus, identify, structure, ownership, estimate, evaluate, plan and manage. Less detailed is PMI's (2013, 2017) division into five stages: risk planning, risk identification, risk analysis, risk response, and risk monitoring and control. With Adams (2008), Lalonde and Boiral (2012) and Purdy (2010), there are again three sub-processes: risk identification, risk analysis and evaluation, and risk response and management.

One could take the position that these all can be reduced to the same thing: identifying risks, analysing them and then managing them. This thesis will use the PMI's classification and will not discuss the other classifications further because they leave out two important processes: risk planning and risk monitoring and control. Failing to include risk planning as a sub-process of the risk management process means not scheduling and designing strategy for implementing the other processes. In fact, the risk planning process should be the very first process in the risk management framework in order to define what is to take place later. Risk monitoring and control is just as important. Following the planning stage, the next step is to identify and analyse risks in order to determine an effective response to them. However, this is not a step to be carried out once; rather, it is a cycle that must be monitored regularly. Since, as was discussed above, the project's prerequisites and environment will keep changing, new risks will arise and will call for different responses. This creates the need for the process of risk monitoring and control. This would suggest a risk management process that lacks this sub-process is not acceptable to various individual and institutional authors, since as discussed above as it invites failure of the risk management process and, perhaps, the project.

The five interdependent sub-processes are explained in more detail in the following subsections.

2.10.1 Risk Planning

"Plans are nothing, planning is everything" – Dwight D. Eisenhower.

The planning process defines how the risk management framework's sub-processes are to be carried out. This part specifies what exactly the managers are supposed to do as well as when and how. Other questions explored in this sub-process are what policies are needed? What resources? Who is responsible for individual processes and how long will they take? Do any personnel need training to improve their risk management expertise (ISO 31000, 2009; PMI, 2004, 2013, 2017; Szymanski, 2017)?

2.10.2 Risk Identification

The risk identification process begins by defining the projects' objectives. The project's risks are then identified, categorised and assessed. Useful tools and techniques for this process may include checklists, judgements based on experience and records, flow charts, systems analysis, brainstorming sessions, stakeholder discussions, review of historical records of similar projects and strengths, weaknesses, opportunities and threats (SWOT) analysis. Such techniques must fit with the specific project, its particular types of risk, the organisational context and the specific objectives of the risk management study (Al Harthi, 2015; Harvett, 2013; Meng & Boyd, 2017; Zoysa & Russell, 2003). The output of the risk identification process is the risk register, which includes the risk description, estimated impacts, risk probability and risk score (Adams, 2008; Lalonde & Boiral, 2012; Purdy, 2010; Ziyu *et al*., 2017).

Altunel (2017), Erdogan *et al.* (2017) and Williams (1995) advise forming a strategy for identifying, controlling and allocating risks early in the construction project's life cycle. It may also be important to point out the potential internal and external risks to the client, contractor and project team in order to anticipate and, ideally, avoid possible claims or disputes. It is important during this process to determine the source of each risk source and its effect (Altoryman, 2014; Raftery, 1999).

2.10.3 Risk Analysis/Assessment

Having identified a particular risk, the next step is to assess its level and priority by analysing the available qualitative and quantitative information concerning the risk description including probabilities and impacts. The objective of risk analysis is to identify and assess the likelihood of a given risk occurring and, if it does, measure its impact on project outcomes. The process begins with a quantitative and qualitative expert evaluation of the probability and impact of the risk which is, in turn, based on the experts' experience (Baker *et al*., 1999; De Oliveira *et al.*, 2017; Dziadosz & Rejment, 2015; ISO 31000, 2009; Ranasinghe, 1994).

As discussed above, risk has been divided into qualitative and quantitative tools. Qualitative tools and techniques include direct judgement, ranking options, comparing options and descriptive analysis. Quantitative tools and techniques are those which can increase the accuracy of the risk analysis process. These include probability analysis, sensitivity analysis, scenario analysis, simulation analysis and correlation analysis (Minassian & Jergeas, 2009). The qualitative and quantitative risk analysis involves:

- Assessing a risk's priority in light of its likelihood and its potential impact (consequences) on the project's objectives, schedule, cost, scope and quality. This is done with matrices that specify combinations of likelihood and impact and take into account organisational thresholds, resulting in ratings of low, moderate and high-priority risk. Elements of the matrix can be descriptive or numeric;
- Assessment of both opportunities and threats;

- Basing the assessments on factual information and data whenever possible and appropriate;
- Making sure to state the assumptions underlying the analysis; and
- Reassessing the qualitative risk scores during the PLC (Harvett, 2013; Meng & Boyd, 2017; Szymanski, 2017).

The risks that the qualitative risk analysis identifies as high-priority are then subjected to quantitative risk analysis, although this is not always required for an effective response. The selection of methods for a given project will depend on its schedule and budget and the need for qualitative and quantitative risk statements.

Scenario analysis is most frequently used in situations of uncertainty. Techniques such as expected value, decision tree analysis, sensitivity analysis and Monte Carlo simulation are usually involved and these can be used to:

- Quantify the possible outcomes for the project, along with their probabilities;
- Determine the probability of achieving the project's objectives;
- Identify project cost, schedule and scope targets that are realistic and achievable, given the project's risks; and
- Determine, given the conditions of uncertainty, the most appropriate project management decisions (Harvett, 2013; Meng & Boyd, 2017).

2.10.4 Risk Response

The objective of the risk response process is to evaluate the possible impacts of the risks that have been identified and devise ways to minimise the negative impacts and maximise the positive impacts as much as possible. As with the risk management process itself, various authors and organisations have come up with various ways to subdivide the risk response process. They have concentrated their attention on negative impacts and, so far, appear not to have suggested any responses appropriate to a risk's possible positive impacts.

Al Harthi (2015), Berkeley *et al.* (1991), De Oliveira *et al.* (2017), Dziadosz and Rejment (2015) and Flanagan and Norman (1993) categorise risk responses as avoidance, reduction, retention or transfer. The categories proposed by Figueiredo and Kitson (2009) are avoidance, mitigation, acceptance, research, transfer and monitoring. APM's PRAM guide (2000, 2004) which, like the other sources mentioned here, is focused on negative impacts, separates risk responses into remove, reduce, avoid, transfer and acceptance. A few authors have turned their attention to the positive impacts; that is, the opportunities that a risk might offer. Cooper *et al.* (2005), Hillson (2004b) and PRINCE2 (2009) focus on effective opportunity management instead.

Risk can bring benefit, including profitable opportunities, as well as loss. Because this thesis focuses on both the positive and negative effects of risk, definitions and divisions are used that take both into account. Cooper *et al.* (2005, 2014), Hillson (2004b) and PRINCE2 (2009) allow nine categories of risk response, involving five categories of threats and four categories of opportunities. Descriptions of these responses are presented below.

<u>Avoiding risk</u>

It is never possible to avoid every risk, but it certainly possible to avoid some of them before the project is launched and to avoid others by changing the project plan (Larson & Gray, 2017). Altoryman (2014) and Jannadi (2008) consider risk avoidance strategy to be a continuous decision-making process to avoid a particular risk completely. Aven (2016), Nicholas (2004) and Oliva (2016) suggest several ways to avoid risks: reducing the project's complexity, lowering the quality requirements for project outcomes and eliminating risky activities.

<u>Mitigating risk</u>

The two strategies for mitigating risk are:

- Reduce the likelihood that the risk will occur; and
- Reduce the impact the risk will have on the project if it does occur.

In general, risk teams favour reducing the likelihood that the risk will occur because as reducing its impact tends to be more expensive (Larson & Gray, 2011, 2017, PRINCE2, 2009).

<u>Transferring risk</u>

Although a risk is not itself changed by transferring it to a different party, its impact on the project can be changed by transferring it to the party with the greatest capacity to control it. Insurance seems to be one way to transfer risk, but it does not actually transfer the risk. Rather, it changes the original risk into a credit risk that may be 'very' costly for a large project. For this reason, modern terminology refers to 'risk sharing' rather than to 'risk transfer'. Where financial risk factors, the contract bid price is also a method for transferring risk (Gladysz *et al.*, 2015; Gray & Larson, 2008; Hillson, 2004b; Larson & Gray, 2011, 2017; Wong, 1998).

<u>Sharing risk</u>

Contractors and clients may devise a contract that allocates the risk amongst them, possibly with each contracting party accepting the risk it is best able to manage. The types of contractual agreement for sharing responsibility for risk (Altoryman, 2014; Borg & Lind, 2014; Hwang *et al.,* 2017; Merrow, 2011; Nicholas, 2004; Suprapto *et al.,* 2016) include:

- *Fixed-price*: The contractor is responsible for nearly all the risk;
- *Fixed-price with incentive fee*: The contractor accepts up to 60% of the risk while the client accepts the rest;
- *Cost plus incentive fee*: The contractor accepts up to 40% of the risk while the client accepts the rest; and
- *Cost plus fixed fee*: The client is responsible for all the risk.

Retaining risk

If a risk cannot be avoided or transferred, such as an earthquake or flood, it can be retained with a contingency plan; that is, an alternate plan that will be applied in order to reduce the negative impact on the project in case that particular risk occurs (Hwang *et al.,* 2017; Larson & Gray, 2011, 2017; Suprapto *et al.,* 2016). Retaining risk can also take the form of legally assigning the cost of that risk from one party to another, similar to insurance (Jannadi, 2008; Torp *et al.,*2016; Wong, 1998).

The responses to positive risks (opportunities) include:

- *Exploitation*: Making sure that the opportunity will occur and that its beneficial impact will be realised;
- *Enhancement*: Taking action to increase the likelihood that the event (opportunity) will occur or to increase its beneficial impact;
- *Rejection*: Deciding not to exploit or enhance the opportunity; and
- *Sharing*: An agreement amongst the parties to share the gain (within pre-agreed limits), generally when the cost of doing so is less than the cost plan (Cooper *et al.,* 2005, 2014).

2.10.5 Risk Monitoring and Control

The objective of the monitoring and control process is to certify that the risk identification, analysis and response processes are continually taking place. This process requires periodically checking the status of the risks identified in the risk register; determining whether or not the project assumptions are still valid; using trend analysis to determine if the risk state has changed;

making sure that proper risk management policies and procedures are being followed; modifying the contingency reserves (cost and schedule) in accordance with project risks (Harvett, 2013); assessing the efficiency of the risk responses; and identifying, assessing and formulating responses to new risks (De Oliveira *et al.,* 2017; Harwood *et al*., 2009). This sub-process includes identifying new risks not only because the project and its environment may change, bringing about new risks, but also because implementing one risk response can create a new risk known as a secondary risk (Cooper *et al*., 2014; Cruz *et al.*, 2006).

Al Mousli and El-Sayegh (2016), Altoryman (2014), Hwang *et al*. (2017) and Smith (2002) argue that every party involved in a construction project carries some risk at some point and every project involves both risk and uncertainty. Contracts should therefore allocate risk responsibility amongst the contracting parties at every stage of the life cycle of the project.

To summarise, risk management is one of nine focus areas in the Project Management Body of Knowledge (PMBOK). Its advantages include identifying the most effective action in a given situation, reducing the project's uncertainty and increasing all parties' confidence that the project's objectives will be achieved, in part by making possible more accurate estimates (Altoryman, 2014; Aven, 2016; Harvett, 2013; Karimiazari *et al*., 2011; Oliva, 2016).

2.11 Factors Influencing the Risk Management Process

As explained above, risk management concerns human beings making decisions according to the specifications and environment of a given project. That decision-making process requires information. In a project's early phase, there may be a great deal of data available from similar previous projects. Past experience, intuitive judgement and historical records are all needed when making a decision about the unknown future. When there is not enough historical data or other information to work with, risk managers should use the subjective judgements of experts in order to identify project risks and propose responses (Ghahramanzadeh, 2013; James *et al.,* 2006; Minassian & Jergeas, 2009). Experience can serve as a database that becomes the decision-makers' best resource, allowing them to draw conclusions from the past that will be applicable to the present and to the future (De Oliveira *et al.*, 2017).

Thus, those involved in a project, including the experts, should engage in continuous learning from past experience, including past projects. Such knowledge can make it possible for them to identify early on the potential risks of their current project and adopt the most appropriate management strategies for dealing with them. Safa *et al*. (2017) and Salah and Moselhi (2016) point out, however, that no two construction projects are the same, which makes it important to identify the risks for each new project using all available information related to that project, rather than assuming that the risks are already known from a previous project.

Although project risk management depends on expert judgement and knowledge, given the complex nature of construction risks, it is not expected that this can be provided by one expert. In addition to this, different experts with different personalities, values, perceptions and preferences will draw different conclusions even from similar stores of information and experience. The risk management process should therefore allow for the aggregation of opinions from a number of experts, which will make it less vulnerable to individual biases (Ghahramanzadeh, 2013; Lester, 2017a).

Because the aim of risk management is to make decisions about the unknown future, it necessarily includes forecasting. The accuracy of that forecasting can be affected not only by individual bias but also by the availability, consistency and quality of data and by the cost and time horizon for producing the forecast. Figure 2.8 depicts Flanagan and Norman's (1993) model for a forecasting process. The figure shows that qualitative and quantitative forecasts depend not only on available techniques and on skill in using the forecasting methodology, but also on human factors such as knowledge, skill, judgement, experience, intuition, prejudice and bias.

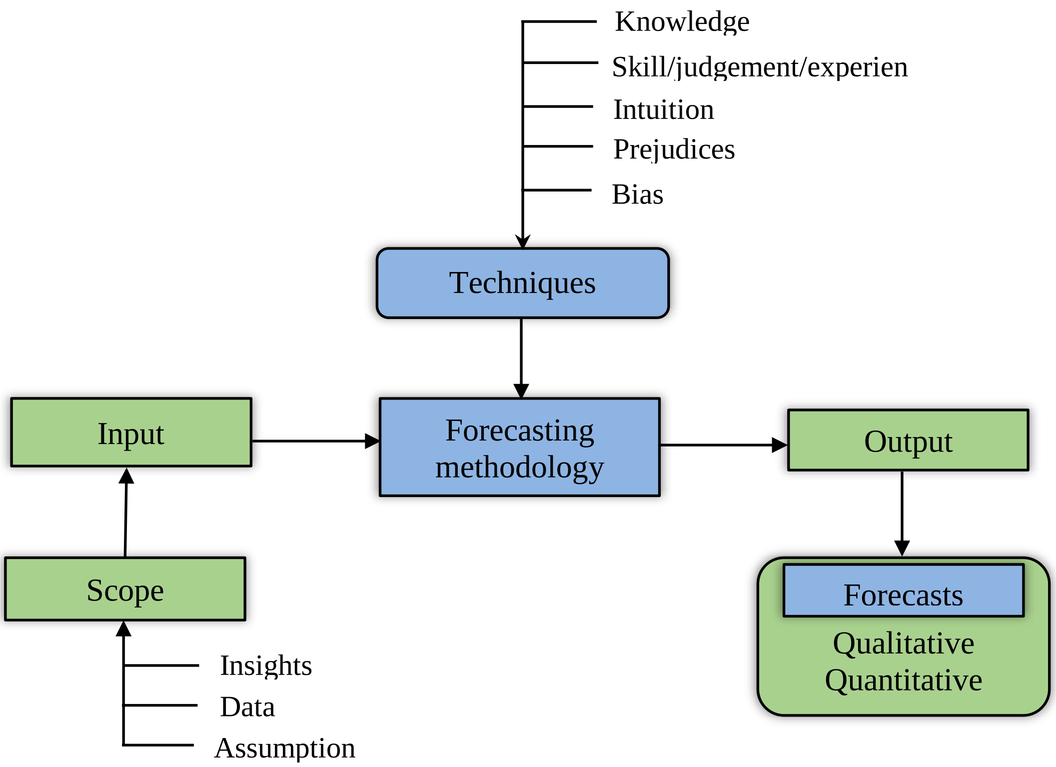


Figure 2.8: The Forecasting Process
Source: Flanagan & Norman (1993, p. 37)

Organisations that are managing projects can use organisational learning to help people make the best use of past experience. Liu and Low (2009) define organisational learning as "*an integrative process during which an organization can meet existing and emerging needs to identify and exploit existing and acquired knowledge assets, increase decision-making potential and develop new opportunities"* (p. 179). To avoid repeating past decision-making errors, it can be worthwhile documenting the lessons learned during the risk management process as a resource for organisational learning. The construction industry, being largely project-based, is not amenable to organisational learning. To make sure that 'mistakes' are later put to use as learning experiences, construction organisations should establish generative learning as an element of their culture and their reward system (Ghahramanzadeh, 2013; McGill *et al.*, 1992). This study recommends a process (discussed in Chapter 6) by which project managers learn to make the best use of their past experience to manage construction project risks.

Yet, even with organisational learning, managerial experience and all of the other techniques and methods available, there is no single optimal way for an organisation to respond to its project risks. Different strategies will serve best given the characteristics of particular risks and of a particular project. What people take to be risk is significantly influenced by their perceptions. The dynamic nature of those perceptions makes risk identification among the more difficult processes that make up the risk management process. Once a project's risks have been identified and analysed, the most effective risk responses should be selected, a choice which depends not only on the nature, probability and consequences of the risks but also on individual or group risk attitudes. Although risk attitude is important for decision-making, it should not to be confused with risk appetite. According to Hillson and Murray-Webster (2011), risk appetite is a tendency, while risk attitude is a *"chosen state of mind with regard to those uncertainties that could have a positive or negative effect on objectives"* (p. 37). As pointed out earlier, the individuals who implement risk management have their own various risk attitudes, as do their groups or organisations.

As highlighted in Section 2.6, individual and organisational attitudes are an important factor in determining whether risk management can deliver its intended outcomes (Arrow & Lind, 2014; Harvett, 2013; Hellier *et al*., 2001; Meng & Boyd, 2017; Serpell *et al.*, 2015). A mechanistic approach to risk management is not likely to be successful because human factors are such an important part of the process. This literature review has already mentioned the long history of research on systematic bias in organisational psychology and decision-making; in particular, the work of Tversky and Kahneman (1981, 1992).

Recent research on project failures identify how systematic bias could be a 'very' useful concept in understanding how rational project management can be derailed by its own decision-making processes (Stingl & Geraldi, 2017; James *et al*., 2006; Shore, 2008). For that reason, it is important to understand how individual attitudes can affect the risk management process (Hillson & Murray-Webster, 2005). Flanagan and Norman (1996) identify three types of risk attitude: risk-loving, risk-neutral and risk-averse. Hillson and Murray-Webster (2005), in contrast, see a spectrum of risk attitudes, ranging from risk-averse (those who are rather uncomfortable with uncertainty) to risk-seeking (those who welcome uncertainty as a useful change). This spectrum is portrayed in Figure 2.9.

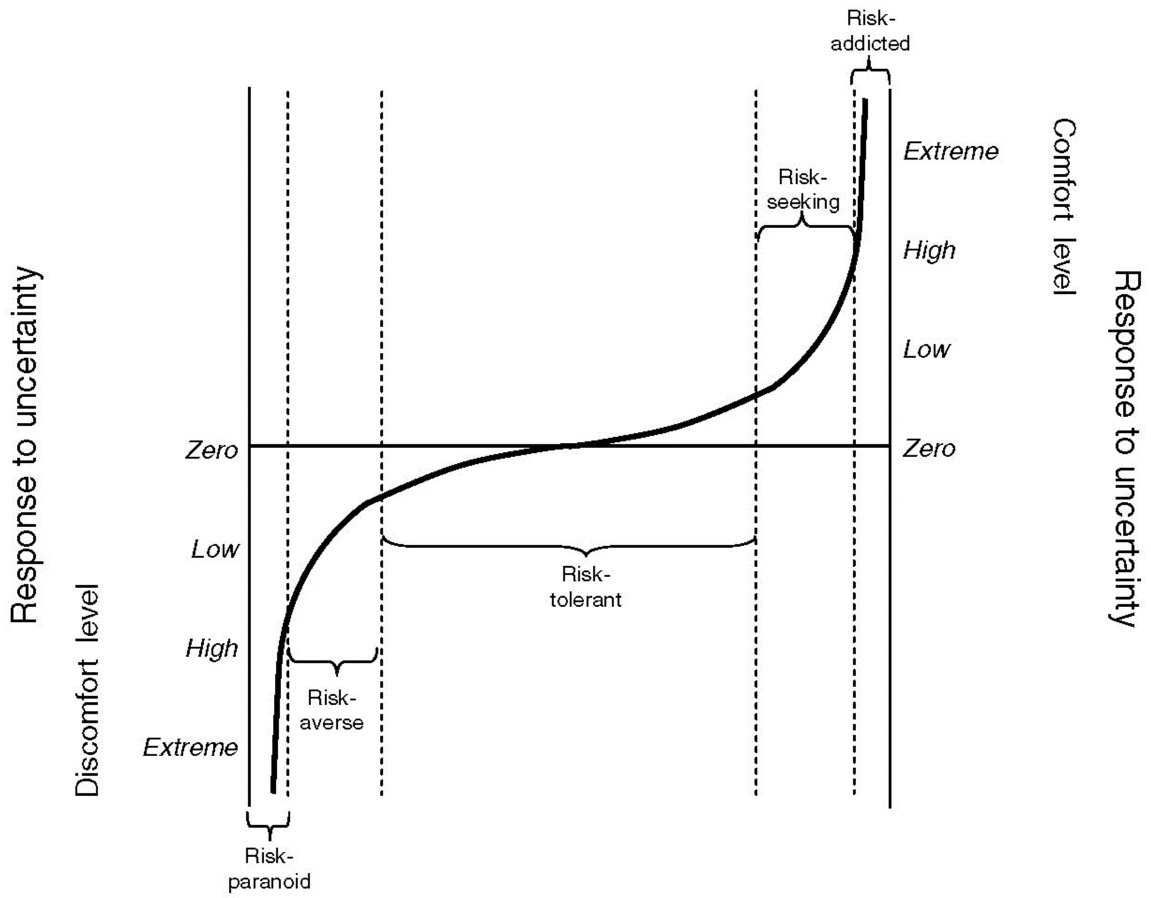


Figure 2.9: Risk Attitude Spectrum

Source: Hillson & Murray-Webster (2005, p. 6)

In its general characteristics, the curve in Figure 2.9 shows key traits of the range of risk attitudes. Hillson and Murray-Webster (2005) identify four fundamental risk attitudes: risk-averse, risk-tolerant, risk-neutral and risk-seeking. Once the level of risk attitude has been assessed and described, it becomes possible to diagnose the sources of bias, which in turn lays open their influence on the risk process (Hillson & Murray-Webster, 2005).

The risk management process needs to take into account the fact that risk attitudes are not only a property of individuals but also occur at the corporate/organisational level. As Hilson and Murray-Webster (2008) warn, "*Group risk attitude has a significant influence on both the decision process and the outcome and if it is left unmanaged the consequences can be unpredictable*" (p. 190).

To determine a decision-maker's risk attitude in a more structured way, one can use utility theory, which captures the trade-offs (preferences) made by individuals and organisations as they make decisions in the presence of risk. Each possible outcome that a decision-maker could choose is assigned a utility value, while the utility function expresses the relationship between each choice and its expected return. The theory assesses the utility function for a given decision-maker and chooses the strategy which maximises the expected utility. It can therefore be used to measure the risk attitudes of those decision-makers who are currently managing risks (Doraid & Wasfi, 2017; Flanagan & Norman, 1993; Ghahramanzadeh, 2013; Hey *et al*., 2010; Keynes, 1921; Knight, 1921; Low *et al*., 2015; Obicci, 2017; Stingl & Geraldi, 2017).

The significance of risk attitude for the risk management process has received attention from various individual authors and organisations. Flanagan and Norman (1993), for example, developed the risk management framework shown in Figure 2.10. Here, risk attitude is a prerequisite for conducting the risk response process because different types of risk attitude will influence the type of risk response that individual managers or the organisation as a whole will adopt.

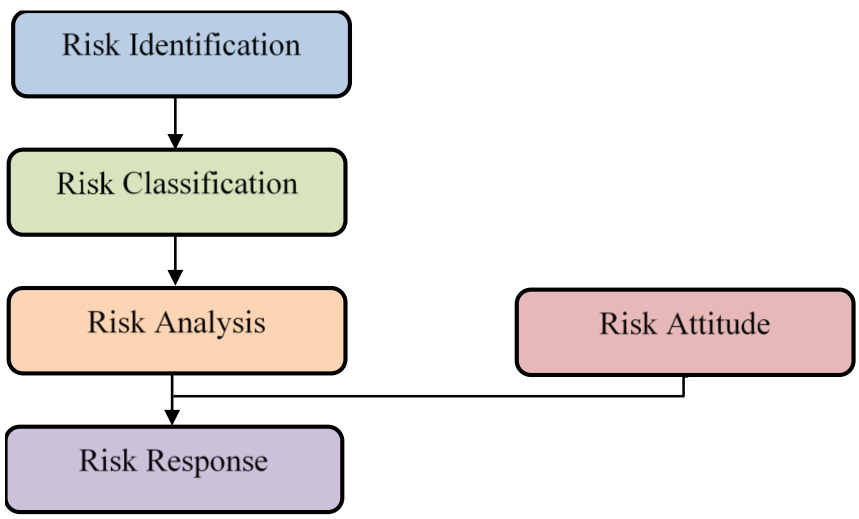


Figure 2.10: Risk Management Framework

Source: Based on Flanagan & Norman (1993, p. 46)

The same underlying concept informs the risk management process proposed in ISO 31000 (2009) and illustrated in Figure 2.11. In this framework, a decision made in the risk evaluation phase is a decision which will then affect the selection of risk responses in the risk treatment phase and therefore it is heavily influenced by the risk attitudes of individuals and of the organisation (ISO 31000, 2009).

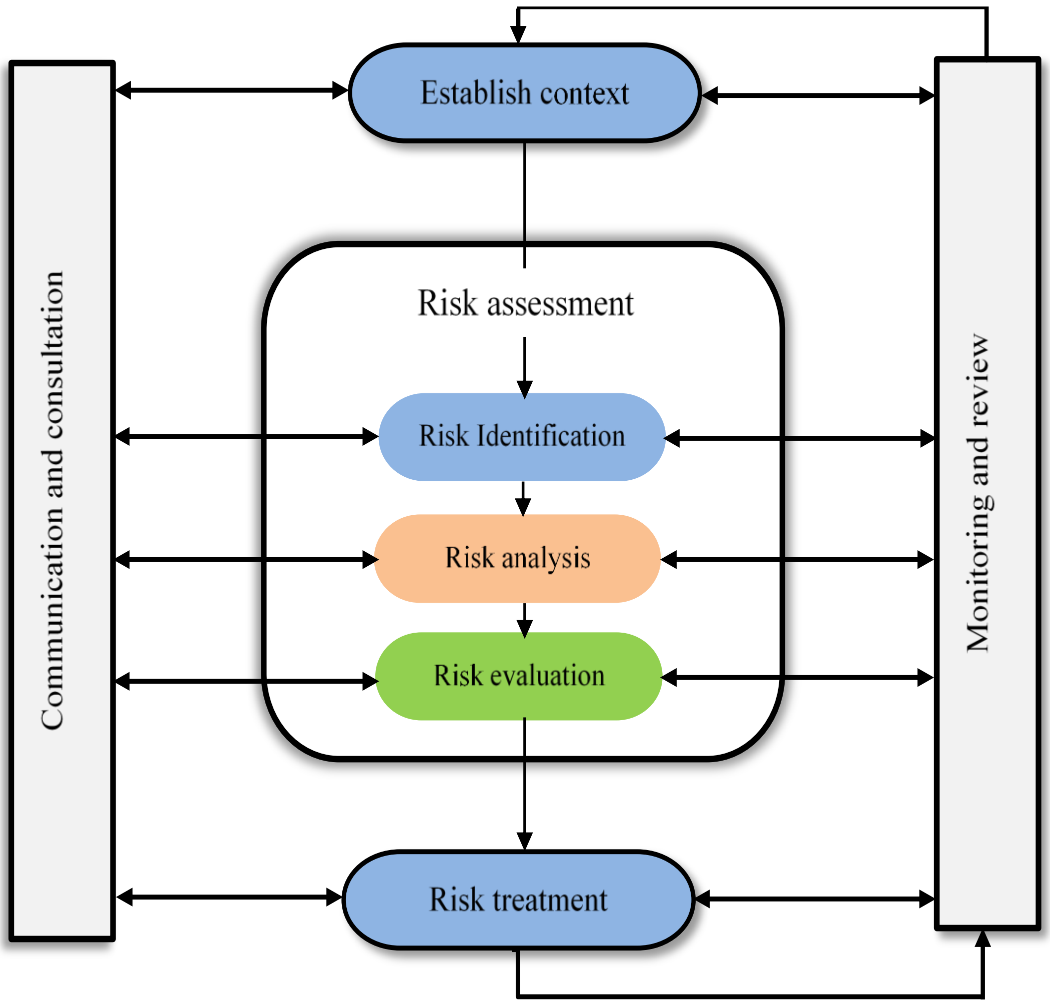


Figure 2.11: Risk Management Process

Source: Based on ISO 31000 (2009, p. 14)

Harvett (2013) and Hillson and Murray-Webster (2004) put forth the 'ABC of risk psychology', where various attitudes (A) produce various behaviours (B) which lead to consequences (C). Individuals' risk attitudes and subsequent behaviour may be influenced by capability and experience, task perception, mistakes, social interaction with other people and organisations as well as the actions of other participants, work environments and other factors. It is noted that all of the above finally result in risk management decisions (Bloom, 2014; Ghahramanzadeh, 2013; Meng & Boyd, 2017; Ritchie & Marshall, 1993).

How an organisation behaves in a particular situation and why it does so is the subject of the field of organisational behaviour. The organisation behaviour may also reflect the influence of individuals, structure, culture and strategy; for example, of a company or a country in which the work is done (Miles & Snow, 1978; Teresa, 2017). Size may also influence an organisation's risk attitude (Forteza *et al*., 2017; Guan & Tang, 2018).

2.12 Identification/Classification of Construction Risks

Construction risks vary according to a country's political, economic, resources and technological issues as well as social and cultural conditions (Zarrouk *et al*., 2017). In the UAE, for example, the construction industry is growing rapidly, with many large and complex projects underway. But, this has placed a huge burden on the industry and generated a lot of risks. El-Sayegh's (2008) and El-Sayegh and Mansour's (2015) studies of risk in the UAE's construction industry emphasise that managing these risks depends on their first being identified and assessed. In their view, most projects involve some risks but many project managers lack sufficient ability to identify or address them. They point out that to try to identify every possible risk is unproductive and time-consuming and hardly guaranteed to succeed. Instead, it would be better to identify the most significant risks and take steps to control those.

El-Sayegh begins by categorising project risks as internal or external depending on the source (Figure 2.12), a method also proposed by PMI (2006, 2013, 2017). As discussed in Section 2.8, internal risk is generated inside the project and is therefore more likely to be controllable. External risk is generated outside the project and its likelihood is probably not controllable; however, it may be possible to have some influence over the consequences (Al Mousli & El-Sayegh, 2016; El-Sayegh & Mansour, 2015; Smith & Bohn, 1999).

Aleshin (2001, p. 213) states that *"internal risks are initiated inside the project while external risks originate due to the project environment."* There are further categories of internal risks and they are as per the part who may be the initiator of the entire process that involves the owner, contractor, consultant and designer, et cetera. At the macro level, external risks are initiated. (Aleshin, 2001; Renault & Agumba, 2016; Rostami & Oduoza, 2017; Wang & Chou, 2003). Figure 2.12 shows the risk breakdown structure (RBS) used to organise the different categories of risk.

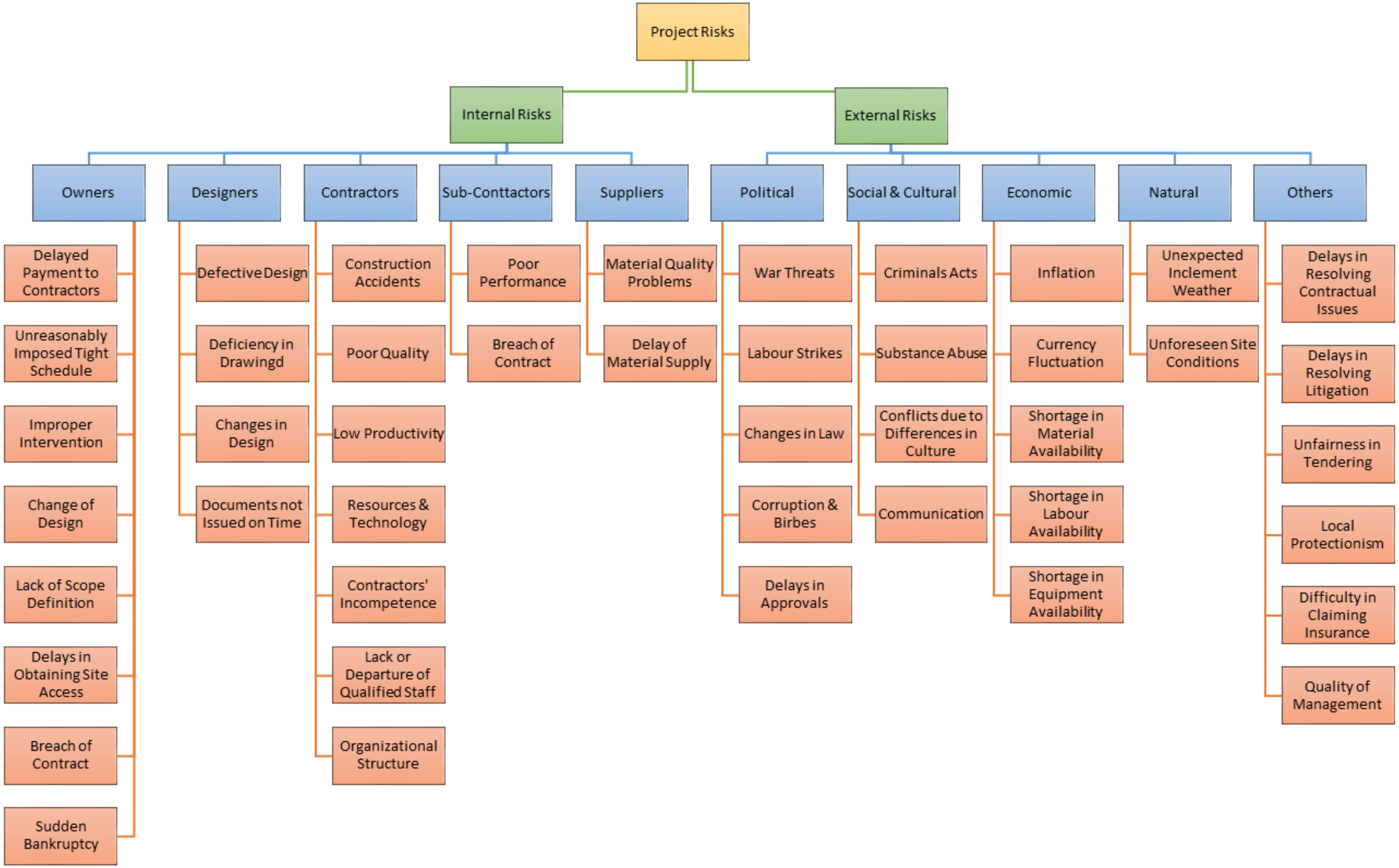


Figure 2.12: Risk Breakdown Structure (RBS)

Source: El-Sayegh (2008); El-Sayegh & Mansour (2015)

The attempted classification of the existing risks in construction into internal and external risks (Figure 2.12) is important and practically useful, as it places particular emphases on different individual risks, identifying their sources as within the company's reach (internal risks) or beyond (external risks). The respective recommendations and risk management strategies should also be developed accordingly, targeting the company management or the government structures. The subsequent sub-division of the internal and external risks into further risk groups (Figure 2.12) is also important as it provides information about possible factors that could be statistically constructed from those smaller groups of individual risks, thus simplifying systemic analytical approach (e.g., based on factor analyses or structural equation modelling). At the same time, it is important to note that no such factor analyses or structural equation modelling were undertaken in several studies (e.g., El-Sayegh, 2008; El-Sayegh & Mansour, 2015). Further sub-division of internal and external risks (Figure 2.12) is also useful to enable the development of specific recommendations targeting particular management groups or government structures having the responsibility of managing particular aspects of economic and social/political development to minimise any construction risks.

2.12.1 Internal Risk

Internal risks are generated within the project and hence their control tends to fall within the auspices of the management of the project (Al Mousli & El-Sayegh, 2016; El-Sayegh, 2014, El-Sayegh & Mansour, 2015), making it more likely that they *will* be controlled (Al Harthi, 2015; Faridi & El-Sayegh, 2006). These risks are subdivided according to the specific originator, such as the owner, designer, contractor, subcontractors and suppliers.

A. Owner Risk

Studies have found that the project owner can be a source of project risk; for example, by delaying payments to contractors, making design changes during the course of the project, intervening in the project, delaying contractors' access to the site, imposing an unreasonably tight schedule on them, not defining the scope of the project, breaching the terms of the contract or suddenly going bankrupt (Al Harthi, 2015; Ng *et al.*, 2004; Remington & Pollack, 2007). Delayed payments can cause financial hardships for contractors. Owners may also demand design modifications which may generate discontinuities, which make it hard or impossible for the contractor to keep to the agreed schedule.

B. Designer Risk

One obvious risk that can originate with the designers is a faulty design. A design may be incomplete, may include too many 'mistakes' or may not even be repairable. The reasons for this may be that the designers of the items may have been pressured into finishing the design phase because the owners were eager to start construction early; this is mainly in order to meet their market objectives or if the completed building is not fit for purpose.

Another risk is that the drawings and specifications may contain 'mistakes', even though they were produced by design professional. If any of the design professionals make changes during the construction phase, such as to improve the design or fix a deficiency, that too invites risk (Al Harthi, 2015; Fazio *et al*., 2008; Gladysz *et al.*, 2015).

C. Contractor Risk

Contractors can generate project risk during construction through cost overruns, delays or the loss of productivity and/or morale, which can, in turn, affect other project objectives. There are also contractor-generated risks with respect to construction quality and the productivity of labour and equipment. Due to a project's uniqueness or to the contractor's inexperience with that type of project, there is also a contractor-generated internal risk of unpredicted technical problems during construction (Al Harthi, 2015; Forteza *et al*., 2017). There are still other risks that can arise if the contractors lack sufficient competence to carry out the project objectives or if they do not use the appropriate construction management resources and techniques, including the use of efficient technology and equipment and efficient procurement of resources and materials to control cost, time and quality (Adam *et al*., 2017; Zaneldin, 2006).

D. Subcontractor Risk

The construction industries around the world, including in the UAE, are becoming increasing dependent on subcontractors because of specialisation; i.e., subcontractors perform what contractors cannot. Although subcontracting is advantageous in many ways for the contractor and for the project as a whole, it also presents risks, including, for example, the quality of work, delayed completion, unsafe work practices, breaches of contract, disputes with the general contractor and sudden bankruptcy (Al Mousli & El-Sayegh, 2016).

E. Supplier Risk

Suppliers can add risk to a construction project if the materials they supply are of poor quality or are delivered late (El-Sayegh, 2008; El-Sayegh & Mansour, 2015; Miller, 2000).

2.12.2 External Risk

External risks are generated by parties and by forces that include social, natural, economic, political and cultural aspects that may be outside the project and beyond the control of the project's management (Aleshin, 2001; Altunel, 2017). Research has identified the following types of external risks.

A. *Political and Sovereign Risk*

Political risks include war or the threat of war, expropriation, political instability, labour strikes and disputes and changes in law and regulations. For example, a law was passed in the UAE in 2011 that prevents construction work between 1 and 3pm during the hottest months of the year, July and August. This obviously affected many of the ongoing construction projects. Corruption and demand for bribes in the supervisory units for construction projects are also a type of political/governmental risk, as are departmental delays in granting permits and approvals (Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016; El-Sayegh & Mansour, 2015; Motaleb & Kishk 2015).

B. *Economic Risk*

Economic risks include inflation, sudden changes in the prices or availability of materials, labour, equipment or services (El-Sayegh & Mansour, 2015; Khan, 2014) and changes in exchange rate that affect the project's profitability, financial stability, exchange rate movements, interest rates, currency exchange rates and foreign investments or joint ventures.

C. *Social and Cultural Risks*

Social and cultural risks include criminal acts, communication, cultural diversity, substance abuse and conflicts due to difference in culture language and traditions (Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; Liu *et al*., 2015; Rajkumar, 2010).

D. *Natural Factors*

There are also natural risks. Such risks include unexpected inclement weather and unforeseen site conditions (Erdogan *et al*., 2017; Loo *et al*., 2013).

E. *Other Factors*

Still, other risks include unfair tendering during the pre-construction phase, delays in resolving contractual issues during the construction phase (including change order negotiations), proper choice of contractors, quality of management, resources and technology issues and delays in resolving contractual issues after the construction phase. There is also the chance of local protectionism (the favouring of local companies), which can be a serious risk; for example, it can be difficult to collect on an insurance claim (Altunel, 2017; Wong, 1998).

As noted in Chapter 1, the construction industry in the UAE is growing rapidly in comparison to that of other countries (Al Harthi, 2015; Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016; El-Sayegh & Mansour, 2015; El-Mallakh, 2014; Motaleb & Kishk 2015). It is not surprising that projects, including those of the UAE, all tend to be focused on ways that help achieve the successful completion of projects. Then, the successful completion of projects is vital to all concerned. Therefore, this study focuses on ways in which this can be achieved in the UAE in particular. The study mainly focuses on risk management for construction projects in the UAE; in particular, by investigating the influence of the important factors identified such as the country-specific economic and cultural contexts.

Because each country's economic, social and cultural conditions are different, it is not surprising that the construction risks differ as well. This, in turn, has a major effect on how to manage risk effectively in that country. In the case of this study, the UAE's construction industry is significantly affected by economic and cultural factors (Akanni *et al.*, 2015; El-Sayegh, 2008, El-Sayegh & Mansour, 2015) and, especially in recent years, has had a number of issues and problems in the construction industry. These economic and cultural factors will be considered in more detail on the national and transaction levels in Sections 2.13 and 2.14 in order to justify the selection of the UAE as a suitable case study for this thesis.

One cause of the construction boom in the UAE is the government's effort to become less dependent on oil income by diversifying the country's economic activity with tourism and commercial and industrial activities. Many mega-projects are either underway or presently in the pipeline. The number, size and complexity of new construction projects has added many new risks aspects, making it important to improve the identification and management of risk in the construction industry (Al Mousli & El-Sayegh, 2016; Akanni *et al*., 2015; El-Sayegh & Mansour, 2015; El-Sayegh, 2008). The following is a review and an investigation of the economic and cultural factors at a national level.

2.13 Economic Factors at National Level

With globalisation, many companies are doing business in multiple locations around the world and, in particular, moving into areas such as the Middle East (Al Mousli & El-Sayegh, 2016; Khodeir & Mohamed, 2015). The United Arab Emirates, as described in Chapter 1, is a wealthy country with a booming construction industry. Their wealth is driven mainly by the oil industry with increasing contributions of agriculture, manufacturing and tourism (El-Sayegh & Mansour, 2015). Twenty-five percent of GDP comes from non-oil industry. The construction projects made up $641.9 billion of the GDP in 2015 (Bank Audi, 2015). It is of note that around 24% of the construction cranes in the world today are in the United Arab Emirates (Al Mousli

& El-Sayegh, 2016). In fact, the UAE's construction industry is ranked eighth in the world for construction technology, only slightly below that of the US, which ranked fifth. UAE is ranked well above Germany, which ranked 16th (Khan, 2014).

A project's economic factors, as defined by Maina and Gathenya (2014), are *"the issues influencing the economic feasibility of the project including the changes in domestic economic conditions of the recipient country or inaccurate project development plan due to unpredictable economic conditions"* (p. 154). Economic factors such as interest rates, currency exchange rates and foreign investments or joint ventures have a large influence on projects (Al Mousli & El-Sayegh, 2016; El-Sayegh & Mansour, 2015; Forteza *et al.,* 2017; Khan, 2014; Khodeir & Mohamed, 2015; Sbia & Alrousan, 2016). Any one of these factors could increase competition, decrease consumption or raise or lower the final sales price and the profit margin.

El-Sayegh and Mansour (2015) identify the most important economic risks for the construction industry as inflation and sudden price changes. Anton *et al*. (2011), Maniar (2010), Nevitt and Fabozzi (2000) and Zarrouk *et al.* (2017) argue that correctly forecasting inflation is necessary in order to update future costs correctly and that lenders are better able to do this than the project's promoters. Builders also see inflation as a major risk (Kartam & Kartam, 2001; Papke-Shields & Boyer-Wright, 2017).

Currency fluctuation is an important economic risk, especially for international projects (Al-Maamary *et al*., 2016; Babatunde & Perera, 2017). Recently, privately financed infrastructure construction in many countries has been based on foreign capital, which, if unhedged, introduces the risk of the devaluation of the local currency. International lenders generally avoid that risk, taking their payments in foreign currency. Public companies and governments used to accept the currency risk but now, with the growing demand for private financing, it is often the project's promoters and therefore ultimately the consumers who assume the risk of currency depreciation. This is mainly because the lender is not willing to do so (Chen *et al.,* 2017; Kayser, 2013; Locatelli *et al.,* 2017). However, this can be managed.

Changes in interest rates are also a significant economic risk for construction projects (Liu *et al*., 2017). Both long-term financing and short-term needs can be supplied using loans with variable interest rates. Forecasting future interest rates in order to calculate the costs of a project depends on a number of assumptions that may or may not prove true. Given the inevitable uncertainty of the global economic environment, it may be a "good idea" to adjust the project according to variable interest rates, although the predictions may never be entirely accurate

(Anton *et al.,* 2011; Zarrouk *et al.*, 2017). Liu *et al.* (2017) note a number of other financial risks including lack of clarity in the allocation of responsibilities for the payment of certain taxes; lack of provisions for partial payment, which would reduce the risk of default; and improper withholding of guarantees on the advance payment.

Research into construction project financing in the UAE shows that local banks tend to finance landmark projects. Another financing comes from Islamic finance structures that provide a unique alternative to traditional financing systems (Biygautane, 2017; Mackenzie *et al*., 2016; Zawawi *et al.*, 2014). The public, government and local authority projects are usually self-financed. Researchers have found that UAE construction projects that had traditionally been financed by the government are now increasingly likely to be financed with private investment (Mackenzie *et al*., 2016).

Akanni *et al*. (2015) identified a number of economic risks to construction projects, including access to capital, inadequate working capital, unexpected price increases for materials and labour, and changes in government policy. Others also identified delays in payment, corruption, availability of finance, cash flow, local taxes, repatriation of funds, cost overruns and changes in market demand or conditions (Ehsan *et al.*, 2010; Odeyinka *et al*., 2008; McNeil *et al*., 2015). Akanni *et al.* (2015, p. 93) suggest that "*economic factors should form the focus of the management of the project environment.*"

Long-term construction projects, in particular, may run a high risk of changes in the interest rate for variable loans, which is why it is so important that their risk management process includes forecasting future interest rates (Anton *et al*., 2011), tax changes and the financial solvency of partners. An increase in tax rates increases financial risk by increasing the risk of loan default and the withholding of guarantees on advance payments (Liu *et al*., 2017). This is a high risk if the contractor has reduced its profit margin in order to win the bidding for the project (Hassim *et al*., 2009; Liu *et al*., 2017). In sum, it is crucial to understand not only the financial risks at the time the bid is placed but also those that may arise throughout the project, as these will have much to do both with project performance and with the profit margins (Demirkesen & Ozorhon, 2017; Mills, 2001; Sambasivan *et al.*, 2017).

Research into economic outlook makes a clear distinction between the financial and the economic environments. According to El-Sayegh and Mansour, (2015), economic research considers how resources are used, while financial environment research considers only the money that flows from those resources; however, both factors contribute to a country's economic activity.

Taking an economic view, it is important to understand how and how efficiently resources are used in construction projects, as a country's major economic cycles can influence its construction industry; and the success of its construction projects (Akanni *et al.*, 2015). One responsibility of the project manager, then, is to ensure that the project is sustainable under a variety of economic conditions.

Because the UAE's economy can be viewed as a non-diversifiable economy based on the oil and construction sectors, changes in the price of oil and in the construction sector directly affect the UAE's economy. In fact, oil prices began to drop in June 2014 and, as of the first quarter of 2017, had decreased about 60% to less than $55 a barrel. Although the International Monetary Fund has predicted the price will be $50 a barrel in 2019 and about $60 in 2020, this may decrease oil income as a whole in any case (According to the Dubai Statistics Center, 2017).

This economic instability has caused relatively high inflation and price fluctuation, although the high inflation can also be attributed to liquidity growth, the dependency of the UAE's central bank on the government and the inappropriate management of oil revenues. This has been compounded by the expansionary monetary policy creating liquidity growth and fostering the dependency of the central bank (Sbia & Alrousan, 2016). Figure 2.13 below shows the inflation rate and other factors for doing business in the UAE.

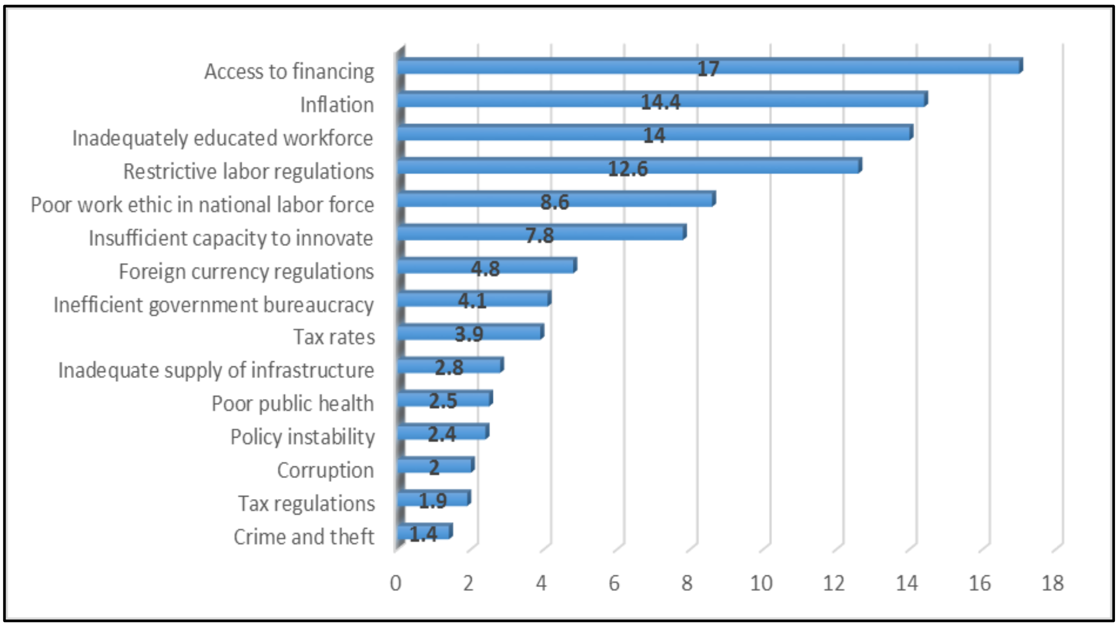


Figure 2.13: The Inflation Rate and other Factors for Doing Business in the UAE

Source: World Economic Forum (2017)

According to a report issued by the World Economic Forum (2017), the UAE's 14.4% inflation in 2017 (Figure 2.13) was the highest of any of the countries in the GCC, followed by State of Qatar at 7.8%, Saudi Arabia at 2.9%, the Kingdom of Bahrain at 2.7%, the Sultanate of Oman at 2.4% and Kuwait at 0.9%. Table 2.3 below shows the mid-term (three-year) inflation trends for the UAE.

Table 2.3: Mid-Term (Three-Year) Inflation Trends for the UAE

Mid-term trends | 3-year averages	2011-2013	2014-2016	2017-2019
Inflation rate (Consumer price index (CPI), annual variation in %)	8.1	10.7	15.3

Source: UAE National Bureau of Statistics (2016)

Inflation in the UAE increased from 8.1% in 2011–2013 to 10.7% in 2014–2016. The UAE National Bureau of Statistics (2016) expects 15.3% in 2017-2019, largely due to a drop in residential real estate prices.

The index rate of consumer prices rose from 118.07 in 2013 to 120.84 in 2014, a growth rate of 2.346%, which was 1.10% higher than 2013's rate. The consumer price index rose 4.31% in the UAE during March 2016, compared with March 2015 (UAE National Bureau of Statistics, 2016). In particular, the prices for housing, water, electricity and gas rose 2.33% in March 2016 over what they had been in February 2016, mainly because of higher rents. The prices for household furnishings and equipment increased 0.08% in March 2016 over those of February 2016; this was mainly because of higher prices for household hygiene items and household services (UAE National Bureau of Statistics, 2016).

In March 2015, rents in Sharjah, Ras Al Khaimah, Fujeirah, Ajman and Umm Al Quwain rose 1.85%, 0.45%, 0.61%, 1.15% and 0.50% respectively, mainly because the prices of housing, water, electricity and gas went up (UAE Ministry of Economy, 2015). In March 2016, prices in Abu Dhabi and Dubai rose 0.77% and 0.20%, respectively, compared with February (UAE National Bureau of Statistics, 2016).

Increasing inflation in the UAE has certainly caused strong fluctuations in the prices of construction materials, with certain materials becoming particularly rare at certain times. Table 2.4 below, which displays one row from the table of indices for bills of materials (building type) on a quarterly basis in 2016, exemplifies the intense price fluctuation for 'steel works (bar)', which rose 22% in the first six months of 2016, 43% in the second six months and 62% in the first three months of 2017 (Dubai Statistics Center, 2017).

Table 2.4: Indices of Bills of Materials (Steel Works)

Description	First two quarters of 2017		Quarters of 2016			
	1	2	1	2	3	4
Steel works (bar)	1,740.42	2,416.67	1,809.58	1,985.00	2,134.58	2,222.92

Source: Dubai Statistics Center (2017)

It is not easy to manage a construction project with fixed-price or billed-rate contracts with the kind of unpredictable price fluctuations shown in Table 2.4. However, Merrow (2011) indicates that this fixed-price approach to contracting may mean that projects in the Middle East, particularly UAE, cost up to 40% more than they should. International companies (contractors/ private sector) are often expected to take inflation, interest rate and currency risks that should properly be taken by the government. Contractors rarely have the balance sheet strength to take on large risks themselves, so they pass on the cost to their clients, with appropriately large buffers and contingencies.

Construction is an important economic sector in any country, but even more so in developing countries (Al-Maamary *et al*., 2016; Altaf, 1979; Babatunde & Perera, 2017; El-Sayegh and Mansour, 2015; Hwang *et al*., 2017). For the UAE, a developing country with a growing population, housing, and construction are basic factors of development. A large portion of the country’s oil income goes to construction projects. There is demand for 200,000 new housing units annually (UAE Ministry of Infrastructure Development, 2017). The fact that both the absolute and the ratio amounts of construction projects in the UAE are quite high means that the country offers a large data sample upon which to conduct major research studies if needed.

Due to economic instability resulting from high inflation and price fluctuations in 2016 and also due to the recent decline in oil prices which began in June 2014, where oil prices have come down about 70%, only 31% of the construction allocated in the 2016 budget it was actually carried out (UAE Ministry of Infrastructure Development, 2017).

An unbalanced economy, budget shortages, intense price fluctuations and high inflation all contribute to high risk for the UAE construction industry. In the past, such cost-related (financial) issues were, for the most part, handled by adjustments in tariffs and regulations but the government has recently (2017) changed many of these rules and the new tariffs now cover only a small portion of the financial losses generated by economic issues (UAE Ministry of

Infrastructure Development, 2017).

Whether or not there is a distinction between the economic and financial risks and risk factors, these factors are of major significance for the successful development of the construction industry in the UAE. This is particularly the case in an oil-dependent economy, like the economy of the UAE, and particularly in the presence of continuously increasing inflation. Improper management of risks in the construction industry has a significant potential to add to the current inflation pressures and further increase the existing risks in construction through a kind of 'positive feedback'. As a result, economic risks and risk factors may be particularly important for the UAE construction industry. Nonetheless, the analysis of these risks in the literature still remains rather rudimentary, with no systemic approach or valid methodology enabling the reliable identification and characterisation of economic risks and risk factors or feasible mitigation strategies or specific industry-focused recommendations in the UAE business environment.

2.14 Cultural Factors at National Level

There are many definitions of corporate culture in the literature. Kivrak *et al.* (2009) argue that corporate culture includes the *"characteristics of the industry, approaches to construction, the competence of craftsmen and people who work in the industry, and the goals, values and strategies of the organizations they work in*" (p. 43). Low *et al*. (2015) extended that definition, contending that culture includes the learned, shared and symbolic traditions that shape behaviour and that these evolve over time.

A society's cultural aspects include customs, lifestyles, demographics, educational levels, norms and values, different ways of thinking, communication, different decision-making processes, different backgrounds, predominant national or tribal characteristics, different languages and different attitudes toward social responsibility (Akanni *et al*., 2015; Motaleb & Kishk, 2013, 2015; Luckmann & Farber, 2016; Oyewobi *et al.*, 2016; Wei & Miraglia, 2017; Yusof & Iranmanesh, 2017). These variables can affect any organisation working within the society, especially if the workers are multicultural.

National culture also plays an important part in construction projects in UAE, due to the mix nationalities involved in the Middle East. The culture, then, has significant implications for risk management. Through its interaction with the processes of cooperation and coordination, the political, institutional and social culture together affects the management style and the speed of processes undertaken (De Bony, 2010; Kim *et al*., 2015; Luckmann & Farber, 2016; Naoum *et al.*, 2015). The cultural diversity must therefore be managed effectively in order to finish projects on time and within budget (Akanni *et al*., 2015; Olawale & Sun, 2015; Zuo *et al*., 2012). As noted and is well known, cultural diversity is a particularly important factor in the UAE, especially where a project manager is more likely to be a foreigner than a local or national person.

Despite this, little is known about the influence of such diversity on construction projects in the UAE. What is known is that the culture of the UAE, as discussed in Sections 2.2.2 and 2.7, is one of high-power distance, low individualism, high uncertainty avoidance and an average level of masculinity (Hofstede, 2015; Hofstede *et al*., 1991). These characteristics offer a framework with which to study the influence of cultural differences on construction organisations, construction management and the success of construction projects.

A recent report reveals that 88.5% of the population of the United Arab Emirates are non-nationals from 132 countries (not all of whom work in construction) (UNDP, 2016). In addition to this, the use of foreign labour as a business strategy is increasing, so the number of foreign workers in the UAE is growing quickly. Cultural diversity is therefore a key issue for any construction organisation's risk management personnel. The human resources sector may have to provide training for specialists, managers and other new employees to familiarise them with the way business is conducted in the UAE, specifically in the construction industry, in order to minimise culture shock (Khan, 2014).

All these aspects make the cultural risks and factors particularly important and may present much bigger problems for the UAE construction industry than in other countries. At the same time, the analysis of these risks in the literature still remains rather basic, with no systemic approach and no detailed identification and characterisation of the respective mitigation strategies or specific industry-focused recommendations as to how to alleviate any existing cultural risks and risk factors.

2.15 Success Criteria for Construction Projects

The literature on projects offers a number of definitions of success, typically in terms of carrying out the client's objectives within the required time and expense and with the required quality, performance goals and fitness for purpose (Ali *et al.*, 2015; Alias *et al*., 2014; Atkinson, 1999; Baccarini, 1999; Chan & Chan, 2004; Chandra, 2015; Davis, 2016, 2017; Demirkesen & Ozorhon, 2017; Lester, 2017b; Meng, 2012; Ramlee *et al*., 2016; Shenhar *et al*., 2001; Todorovic *et al*., 2015; Williams, 2016; Ziyu *et al*., 2017). In their report on *The Project*

Management Body of Knowledge, PMI (2004) proposed that the measuring the success of a project according to what is known as the 'triple constraint': cost, time and scope (PMI, 2004). The 2008 revised edition of the same report (2008, 2017) redefines the scope, cost and project schedule in the context of management performance standards.

Performance is not only a matter of efficiency but also of results. To measure construction project success, many key performance indicators (KPIs) have been identified, including indicators of client satisfaction, stakeholder engagement, service delivery, investment return, urban renewal, defect minimisation, trust, dispute avoidance, innovation, safety and standards. Three of the most frequently used KPIs are on-time completion (time), completion within the agreed budget (cost) and non-defective workmanship as specified (quality) (Langston, 2012). The performance criteria identified by Lester (2017b) are also time, cost and quality.

There are inevitable interactions between time, cost and quality. Scholars and practitioners alike understand that there will be trade-offs in optimising any of these KPIs. For example, finishing a project more quickly will usually increase the cost, whereas reducing the cost will often also reduce the quality. Raising the quality standards will usually mean the project takes more time to deliver (Lester, 2017b; Toor & Ogunlana, 2010).

Additionally, Pardede and Salinas (2013) studied stakeholder views on project success; they found that stakeholders assessed success in multiple dimensions using short and long-term perspectives. These dimensions are organisational benefits, learning, outcome and product. The organisational benefits category includes the advantages that the partner organisations obtained from the project. The learning category refers to the lessons learned from the project. Then, the outcome category refers to the condition when the change in the end user's behaviour is achieved. Finally, the product performance category refers to the technical performance of the product.

After conducting a survey of around 400 construction practitioners in the UK, with a response rate of 30%, Meng (2012) states that it is common for construction projects to incur time delays, cost overruns and quality defects. The survey responses indicated that 35.6% of the projects had been delayed, 25.2% had gone over budget and 17.7% had suffered significant defects. These setbacks were more common in projects with traditional procurement relationships than in projects with partnering (or relationship management) arrangements. Meng's conclussion is that *"time, cost and quality are the three most important indicators to measure construction project performance"* (p. 188).

Although project management performance in the UAE construction industry has not yet received much attention, the existing research does shows that poor performance is a serious problem. Al-Hajj and Sayers (2014) and Issa's (2014) study of performance in the context of project management in the UAE construction industry found that more than one-third of projects demonstrated poor performance. In a comparison of project management benchmarks, project managers in the UAE showed poor performance in comparison to international benchmarks (construction performance in the UAE and other countries is discussed further in Section 2.18). More importantly, this failure was at the implementation level, not at the strategic level. Issa (2014) also found that, although project managers in the UAE construction industry were experienced in construction and had adequate professional qualifications, they lacked experience in project management. The author speculated that the poor performance observed could be attributed to the fact that project management was viewed as a separate discipline, not something these projects managers themselves needed to know. Such findings highlight how important it is to improve risk in the UAE construction sector by gaining a deeper understanding of stakeholders' practice and their perception of various components of risk management.

Measuring project success merely in terms of time and budget is often insufficient, especially in the longer term following the completion of the project. As Shenhar *et al.* (2001) point out, *"Quite often, what seemed to be a troubled project, with extensive delays and overruns, turned out later to be a great business success"* (p. 713). Many authors have noted the case of the Sydney Opera House, which took three times longer and cost five times more than planned. Yet it soon became Australia's most famous landmark and is now a must-visit location for tourists (e.g., Harvett, 2013; Shenhar *et al*., 2001). Most landmark projects have this problem, and design change is a leading factor as well as a change in scope.

A review of the literature shows that there is a high incidence of projects failing to meet the expectations of clients, particularly with complex projects annually in the presence of uncertainty and complexity (Flyvbjerg *et al*., 2003; Kutsch *et al*., 2011; Nguyen *et al*., 2015). The Project Management Institute Pulse of the Profession (2015) reports that 38% of projects fail to meet expectations. The incidence of cost overruns increased from 56% in 2012 to 59% in 2015. Time overruns also increased from 71% in 2012 to 74% in 2015. On average, organisations lose $109 million (10.9%) per $1 billion spent on projects annually due to projects' failure to meet expectations. In civil works and building projects, complexity of project is a major cause of cost overruns (Mott MacDonald, 2002). The problem is much greater for government projects when cost estimates are adopted by politicians and their advisers (Adam *et al*. 2017; Flyvbjerg *et al*., 2003; Love *et al*., 2015). An example of notable failures is detailed below:

1. The Channel Tunnel project (1987–1994) had an estimated cost of £2,600 million but on completion the cost was overrun by 80%, resulting in a blowout of £4,650 million (Flyvbjerg *et al*., 2003; Nguyen *et al*., 2015);
2. Charles de Gaulle airport (2004): The roof of Terminal 2E collapsed, killing four and injuring three less than a year after opening (Guo *et al*., 2013); and
3. Berlin airport (ongoing construction): Almost a decade later than planned, because of "*conceptual design flaws and lack of quality management*" (Davis, 2016. p. 4).

Taking the literature discussed above into account, the concepts raised are added to the 'triple constraint' measure to provide the following more comprehensive and balanced set of criteria for success. These are:

- Project objectives being fulfilled satisfactorily;
- Project delivered on schedule;
- Project did not exceed its budget;
- Project's quality objectives were met;
- Clients remained satisfied after the project's delivery;
- Cordial relationships were maintained during and after completion in all aspects of the project;
- Communication was direct and appropriate;
- There were few or no disputes or claims neither during the project nor after its completion; and
- Quality and performance service were at acceptable levels (Ali *et al.*, 2015; Alias *et al*., 2014; Atkinson, 1999; Baccarini, 1999; Chan & Chan, 2004; Chandra, 2015; Davis, 2017; Harvett, 2013; Lester, 2017b; Meng, 2012; Obicci, 2017; Ramlee *et al*., 2016; Shenhar *et al*., 2001; Todorovic *et al*., 2015; Williams, 2016; Ziyu *et al*., 2017).

This is considered an appropriate set of criteria for this thesis to use for measuring construction project success and will be used in this study. Section 2.16 below reviews and summarises a variety of papers on construction projects, their associated risks and the implementation of the risk management process.

2.16 Risk and Risk Management in Various Countries

Among all the papers studied for this research, this study reviewed the findings of those where a specific country was chosen as a case study. The work of Mills (2001) in Australia, Adams (2008) in the UK, Dey (2009) in India, Grace (2010) in the US, Davis (2017) in the UK, Ghahramanzadeh (2013) in Iran, Chandra (2015) in Surabaya (Indonesia), Baghdadi and Kishk (2015) in Saudi Arabia, Aleshin (2001) in Russia, Cruz *et al.* (2006) in Spain, Hassim *et al.* (2009) in Malaysia, Ling & Li (2012) in China, Khodeir and Mohamed (2015) in Egypt, Hassanein and Afify (2007) in Egypt, Kim *et al*. (2015) in Korea, Rostami and Oduoza (2017) in Italy, Zou *et al*. (2007) in China, Biygautane (2017) in Kuwait, Saudi Arabia and Qatar, Aje *et al.* (2016) in Nigeria, including in the UAE (Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; Al-Hajj & Sayers, 2014; El-Sayegh, 2008; El-Sayegh & Mansour, 2015; El-Sayegh, 2014; Issa, 2014; Khan, 2014; Ling *et al*., 2012; Motaleb & Kishk, 2010; Motaleb & Kishk, 2015), are all generally concerned with the categorisation of risk. This study reviewed the pertinent research in which the authors identify key risks and risk management strategies. The purpose of this section is to accumulate an understanding of the topic to generate clear and direct questions for the semi-structured interviews and the pilot study for the initial empirical research components of this thesis.

Wilson (1982) examined the roles of the owner and the architect/engineer in preventing and resolving claims growing out of construction projects in the US. Such claims were the result of extra work, project delays and acceleration, lack of management, limited site access and changes in the work schedule.

Ireland (1985) compared 14 office and hotel projects carried out by a leading Australian contractor with 22 similar projects carried out by a similar US contractor and subsequently compared all of these projects with the performance of a leading UK contractor. One of the major findings was that for every 107 days the US contractor took to finish a project, the UK contractor took 118 days and the Australian contractor took 136 days; that is, Australian projects took 30% longer than American projects did.

The study showed that increasing the planning during design and co-ordination across the design-construction interface helped to reduce significantly construction time and reduced the cost of the project overall. Increasing variations to the contract, the complexity of the building, the number of storeys and the extent of industrial disputes all increase the construction time significantly. Increasing the architectural quality, variations to the contract and the number of nominated subcontractors all significantly increase the construction cost. To boost architectural quality, it helps to generate more alternative designs, increase the cost per square metre and plan the construction process as part of the design process, which in turn will include value analysis.

Ogunlana *et al*. (1994) studied building project delays in Thailand, which they chose as an example of a developing economy. They concluded that the issues of the construction industry in a developing economy could be tiered in three layers: (1) shortages or inadequacies in industry infrastructure, mainly the supply of resources; (2) problems generated by clients and consultants; and (3) contractor incompetence.

Kumaraswamy *et al*. (1998) surveyed the construction delays in Hong Kong, as seen by contractors, clients and consultants, and the factors affecting productivity. The survey showed that different parties had different perceptions of how important various factors are. These differences in outlook reflected their experiences, possible prejudices and lack of communication.

Mansfield *et al.* (1994) studied delays and cost overruns in construction projects in Nigeria. The most important factors were poor contract management, financing and payment for completed work, changes in site conditions, shortages of material and improper planning.

Al-Momani's (2000) quantitative analysis of construction delays used records of 130 public building projects in Jordan between 1990 and 1997 to run regression models of the relationship between actual and planned project duration for different types of building. The analysis included the reported frequencies of time extensions for types of delay categorised by cause. The main causes of delay concerned designers, user changes, weather, site conditions, late deliveries, economic conditions and increases in quantities.

Frimpong *et al*. (2003) identified 26 factors in delays and cost overruns in groundwater construction projects in Ghana and ranked them by importance. Respondents to the study included public and private clients, consultants and contractors. The most important cause of delay was payment difficulties, followed by poor contract management and material procurement.

Oztas and Okmen (2004) studied techniques for project risk identification, risk analysis and cost risk analysis in Turkey's fixed-price design-build contract system. Their objective was to demonstrate from the perspective of designer-contractor firms the results of failing to apply risk identification and analysis to fixed-price design-build projects during a time of economic difficulty in Turkey. They identified 14 risk factors from project documents, interviews and contract clauses. The greatest risk factors were inflation, the exchange rate and bureaucratic problems.

Research into downside risks in Spanish construction projects, conducted by Cruz *et al.* (2006) identified lack of project management, project risk management maturity and political issues. Zou *et al*. (2006) identified and analysed risks in the development of construction projects in Australia from the perspectives of stakeholders and PLC. They found that many risks occur during more than one phase and that the construction phase is the riskiest, followed by the feasibility phase.

In a study of the Chinese construction industry, Tang *et al*. (2007) compared risks in terms of their criticality and evaluated the methods and risk responses used by the various parties involved. In their ranking, the five most critical risks are poor quality of work, premature failure of the facility, safety, inadequate or incorrect design and financial risk. They found that existing risk management systems are insufficient for managing risks, with the main problem being the lack of a joint management mechanism. Their research indicates that risk management processes need to include an information management scheme and partnering principles to facilitate the open communication between participants which is necessary to manage project risks collaboratively.

Hassanein and Afify (2007) used a case study of Egyptian power station projects to research contractors' perceptions of construction risks and their attitudes concerning risk identification and management. They found inconsistency in contractors' risk identification behaviour and learned that previous experience with the same owner has a negative effect on the contractor's risk identification effort.

Liu *et al*. (2007) investigated risk management and insurance in the Chinese construction industry, finding that the managers of Chinese construction projects knew very little about risk management. Most of their respondents acknowledged the importance of risk management skills, but these were not as well developed in China as were project management skills. The most important obstacle was an unsupportive culture, although the attitudes and perceptions of the contractors were also factors.

Using a questionnaire completed by construction experts in the UAE, both local and foreign, El-Sayegh (2008) investigated 42 significant risks identified from a literature review. The first section of the questionnaire collected the respondents' personal information and the second section sought their perceptions of the probability of certain events taking place and the allocation of each of these risks to the clients, consultants and contractors. The researcher used a risk breakdown structure to categorise risks according to their sources—five external categories and five internal categories, each with their specific risk factors nominated. The internal risk categories were clients, designers, contractors, subcontractors and suppliers; the external risk categories were political, social and cultural, economic, natural and other categories. El-Sayegh's study identified the 10 most significant risks for the UAE construction industry. A comparison between the perceptions of experts from local and foreign companies found both groups in agreement that the greatest risks were inflation and sudden changes in prices.

Perera *et al*. (2009) investigated construction projects in Sri Lanka, finding scope change and tentative drawings to be the two greatest risks. The authors conclude that there is no single optimal risk response and therefore an organisation needs a variety of strategies.

Pourrostam and Ismail (2011) sought to identify the chief causes and consequences of delay in Iranian construction projects. The 10 main causes were poor site management and supervision, delay in progress payment by clients, change orders by the client during construction, ineffective project planning and scheduling by the contractor, contractor's financial difficulties, client's delay in decision-making, delays in producing design documents, client's delay in reviewing and approving design documents, poor contract management by the consultant and problems with subcontractors. The research identified six negative impacts of delay: time overrun, cost overrun, disputes, arbitration, litigation and total abandonment.

Altoryman's (2014) research in Kuwait and Bahrain found that the main contributors to delays there were building permit approval, changes to orders from client, changes to drawings, incomplete document inspections, changes in specifications, poor decisions made during the development stage, approval of shop drawings, design development and changes to laws and regulations. The perceived share of responsibility was 44% for the contractor, 24% for the client, 14% for the government, 6% for the consultant and 12% shared.

Khan (2014) conducted a study on the subject of the national culture of the construction labourers in a migrant state and he explored how cultural behaviour influenced the overall performance of construction plans while the labourers were involved in their work. Khan's study concluded that if a migration strategy is formed by sending as well as receiving migrants to different countries, it will have positive outcomes both socially and financially on the migrant labourers and their families. Khan's study emphasises the good work practices indicators that are closely linked to the culture of migrant construction labourers from Bangladesh, India, Pakistan and China working in the UAE. Khan notes that in the UAE, the national culture of the migrant construction labourers is not similar to the one figured out by Hofstede almost four decades ago (Khan, 2014). Khan found:

- A high UAI was shown by Indian construction labourers;
- Pakistani labourers revealed high MAS;
- LTO and IDV were revealed by Bangladeshi labourers; and
- Chinese construction labourers revealed high IDV and LTO.

The aforementioned study further recommends that managing the cultural differences could aid in making the projects more accomplished, which could be constructive and advantageous for the migrant's sending country as well as the host country along with the individual migrants and their household.

Musa *et al*. (2015) investigated external environment factors (political, economic, and social) in Nigeria. Using both interviews and questionnaires with 276 construction professionals, they found that political, economic and social factors played an important role in the success (or failure) of Nigerian housing projects. This highlights the importance of managing risk in light of the country, the industry and the type of project. Fernando *et al*. (2017) studied the major financial risks affecting construction contractors in Sri Lanka. The most important factors were variations in material prices, interest rate, material shortages and exchange rate. As a result, the ultimate knowledge about risks in construction industries and any mitigating strategies should be derived from the consideration of a variety of different countries with different economic and political structures and agendas. This will enable careful segregation of any common risks present in all or most of the countries from less common risks that are characteristic to only a few countries and that are caused by specific conditions of those countries (e.g., economic, cultural, political, environmental and geographical background), rather than the construction industry in general. Table 2.5 below summarises the previously discussed sample of studies of the major risks in construction projects.

Table 2.5: Major Findings of Some International Studies of Risks in Construction Projects

No.	Author (Year)	Country	Risks/Findings
1	Ireland (1985)	Australia and United States (US)	Australian construction projects took 30% longer than similar US projects. Improving planning during the design stage significantly reduces construction time and cost.
2	Ogunlana et al. (1994)	Thailand	Three general problems: (1) inadequacies of the industry infrastructure and supply of resources; (2) problems generated by clients and consultants; and (3) contractor incompetence.
3	Mansfield et al. (1994)	Nigeria	The most important risk factors: difficulties with payments for completed work, poor contract management, changes in site conditions, shortages of materials and improper planning.
4	Kumaraswamy et al. (1998)	Hong Kong	Significant diversity of perceived risks by different parties to the construction process.
5	Al-Momani (2000)	Jordan	Main causes for delays: project changes, weather, site conditions, late deliveries and economic conditions.
6	Frimpong et al. (2003)	Ghana	Payment difficulties, poor contract management and material procurement.
7	Oztas and Okman (2004)	Turkey	14 risk factors. The major factors are: inflation, exchange rate and bureaucracy.
8	Cruz et al. (2006)	Spain	Political issues/poor project management/inadequate prequalification system.
9	Zou et al. (2006)	Australia	Tight project schedule/design variation.
10	Tang et al. (2007)	China	Poor quality of work/premature failure of the facility/safety/inadequate or incorrect design/lack of a joint management mechanism. Strategy: open communication between participants.
11	Liu et al. (2007)	China	Lack of managerial knowledge of risk management/unsupportive culture/attitudes and perceptions of contractors.
12	El-Sayegh (2008)	UAE	42 significant risks. Most significant risks include inflation and sudden changes in prices.
13	Perera et al. (2009)	Sri Lanka	Scope changes/tentative drawings.
14	Pourrostam and Ismail (2011)	Iran	10 main risks: poor site management and supervision, payment delays, changing orders, poor project planning and scheduling, contractor's financial difficulties, delays in decision-making, delays with design documents, delays with approving design documents and poor contract management.
15	Altoryman (2014)	Kuwait and Bahrain	Building permit approval/changing orders/changing drawings/incomplete document inspections/ changing specifications/poor decisions during the development stage/shop drawings approval/ changing laws and regulations.
16	Fernando et al. (2017)	Sri Lanka	Variations in material prices/material shortages/exchange rate.

Source: Author (2018)

Table 2.5 provides a summary of the major identified risks and other significant outcomes identified in the studies described in this section of the literature review. In particular, the table demonstrates the high level of diversity in the identification and characterisation of individual risks in construction industries. Different and inconsistent definitions of risks in construction industries, with some of them being too general and non-specific (e.g., ‘attitudes and perceptions of contractors’, ‘unsupportive culture’, ‘economic conditions’), significantly add to the diversity of the identified risks and possible causes for project failures and delays. Finally, the typical lack of adequate statistical methodologies in the conducted analyses makes the identified risks unreliable, potentially incorrect and not comparable with each other.

Considering the international studies of the risks in construction projects discussed above and the evidence provided in Chapter 1 about the situation in the UAE, it is expected that major differences (provided in Chapters 5 and 6) will emerge from the findings of this research.

2.17 Construction Performance in the UAE and Other Countries

The above-demonstrated diversity of the identified risks in construction industries (Table 2.5) also illustrates the significant difficulties with comparisons of existing findings in construction risk research in different countries. These difficulties are also relevant to comparisons of performance characteristics of construction industries and companies in different countries. For example, Table 2.6 presents a summary of the major performance indicators identified and considered in the construction industries in a number of different studies. The differences of the identified performance indicators, with only a few of them overlapping for different countries (Table 2.6), make a general comparison of performance characteristics in different countries unreliable. It is argued that the demonstrated variance of the performance indicators (Table 2.6) is largely related to the different methodologies and tools for the determination of such performance indicators (including differences in surveys, interviews and methods for their analysis) than to the intrinsic differences in these indicators across the countries (although such intrinsic differences may also exist). Thus, the variability of the methodologies and tools adopted by different research groups, as well as the lack of a common approach to the definition and determination of performance indicators, are significant contributors to the difference of the identified performance indicators in the construction industries. This diversity creates difficulties for a sensible and reasonably valid comparison of industry performance in different countries.

Nonetheless, some of the earlier studies presented a comparative analysis of construction performance characteristics in different countries. Such studies normally used common methods for the determination and characterisation of performance characteristics in construction industries in different countries, which created a reasonable ground for their comparison across the countries considered in each study. In addition to this, some existing studies focused on fundamental performance indicators such as project delays and schedule overrun. These rather commonly used performance indicators can be used for comparisons between different countries if project delays and schedule overruns are commonly defined in an unambiguous way.

Table 2.6: Summary of the Identified Major Performance Indicators in Different Countries by the Indicated Studies

No.	Author (Year)	Country	Performance indicators	
1	Jastaniah (1997)	Saudi Arabia	1. Client satisfaction 2. Planning period 3. Staff experience 4. Communication 5. Safety	6. Closeness to budget 7. Profitability 8. Payment 9. Claims
2	Egan (1998)	UK	1. Predictability – time, cost 2. Construction cost 3. Construction time 4. Productivity	5. Profitability 6. Safety 7. Defects 8. Client satisfaction
3	Department of the Environment, Transport, and the Regions (DETR) (2000)	UK	1. Time 2. Cost 3. Quality 4. Client satisfaction	5. Client changes 6. Business performance 7. Health and safety
4	Pillai et al. (2002)	India	1. Benefit 2. Risk management 3. Project status 4. Decision effectiveness 5. Production	6. Cost effectiveness 7. Customer commitment 8. Stakeholders 9. Project management
5	El-Mashaleh (2003) and El-Mashaleh et al. (2007)	US	1. Schedule performance 2. Cost performance 3. Client satisfaction	4. Safety 5. Profitability
6	Ramirez et al. (2004) and Alarcon et al. (2001)	Chile	1. Safety 2. Productivity 3. Quality 4. Efficiency of labor 5. Rework	6. Training 7. Planning effectiveness 8. Cost variation 9. Schedule variation

Table 2.6: Summary of the Identified Major Performance Indicators in Different Countries by the Indicated Studies Continued

No.	Author (Year)	Country	Performance indicators	
7	Cheung et al. (2004)	China	1. People 2. Cost 3. Time 4. Quality	5. Safety 6. Client satisfaction 7. Communication 8. Environment
8	Wong (2004)	UK	1. Staff experience 2. Resources 3. Site management 4. Safety	5. Contractor experience 6. Time 7. Cost 8. Quality
9	Yu et al. (2007)	Korea	1. Profitability 2. Growth 3. Stability 4. Customer satisfaction 5. Market share	6. Development 7. Technological capability 8. Business efficiency 9. Informatization 10. Organization competency
10	Nudurupati et al. (2007)	UK	1. Quality 2. Clients satisfaction 3. Employee satisfaction 4. Environment impact	5. Safety 6. Time 7. Cost
11	Rankin et al. (2008) and Canadian Construction Innovation Council (CCIC) (2007)	Canada	1. Cost 2. Time 3. Quality 4. Safety	5. Scope 6. Innovation 7. Sustainability 8. Client Satisfaction
12	Luu et al. (2008)	Vietnam	1. Construction cost 2. Construction time 3. Customer satisfaction 4. Quality management	5. Team performance 6. Change management 7. Material management 8. Safety
13	Skibniewski and Ghosh (2009)	US	1. Construction cost 2. Construction time 3. Predictability cost and time	4. Defects 5. Client satisfaction product
14	Toor and Ogunlana (2010)	Thailand	1. On time 2. Under budget 3. Specifications 4. Efficiently 5. Effectiveness	6. Safety 7. Defects 8. Stakeholders 9. Disputes

Table 2.6: Summary of the Identified Major Performance Indicators in Different Countries by the Indicated Studies Continued

No.	Author (Year)	Country	Performance indicators	
15	Wang et al. (2010)	US	1. Profitability 2. Return on capital 3. Cash flow 4. Reliability 5. Customer focus	6. Market shear 7. Quality 8. Internal business 9. Innovation and learning 10. Environment
16	Horta et al. (2010)	Portugal	1. Productivity 2. Profitability 3. Growth	4. Safety 5. Customer satisfaction 6. Predictability
17	Construction Industry Institute (CII) (2011)	US	1. Cost 2. Schedule 3. Changes	4. Accident 5. Rework 6. Productivity
18	Meng (2012)	UK	1. Trust 2. No-blame culture 3. Communication	4. Problem solving 5. Risk allocation 6. Performance measurement
19	Al-Hajj and Sayers (2014) and Al Mousli and El-Sayegh (2016)	UAE	1. Cost and schedule 2. Poorly written contracts 3. Objective	4. Knowledge and Experiences 5. Quality 6. Communication

Source: Author (2018)

For example, the performance of international development projects was compared in India, China, Bangladesh and Thailand (Doloi *et al*., 2012). It was shown that the average schedule overrun was the highest in India, amounting to about 55% of the initial schedule (Doloi *et al*., 2012), which was the poorest performance outcome in terms of project delays among the four countries. Further, the comparative analysis of the key parameters causing construction delays in the UAE, Kingdom of Saudi Arabia (KSA) and Lebanon revealed that some of the common causes for delays were approval delays, owner' slow decision-making and material shortages (Faridi & El-Sayegh, 2006). These factors were common to the construction industries across the region. At the same time, other risks, including shortage of skills and workers, poor supervision, poor site management, unsuitable leadership, and shortage and breakdown of equipment (AL Mousli & El-Sayegh, 2016; Meng, 2012; Ramlee *et al*., 2016; Williams, 2016), that contributed to construction delays in the UAE, were less common and did not show significance in the context of the KSA construction industry. It was found that around 50% of the construction projects in the UAE were delayed in comparison with the planned completion time. Further comparisons with, for example, the findings for India, are difficult because of differences in the approaches to the characterisation of the delayed projects. While Doloi *et al*. (2012) calculated the average overrun of the initial schedule as a percentage of that schedule, Faridi and El-Sayegh (2006) evaluated the number of the delayed projects irrespective of the length of the schedule overrun.

Another detailed analysis of performance characteristics in the UAE construction industry was conducted by Al-Hajj and Sayers (2014), who defined 'poor performance' as overruns of the planned project delivery schedule by more than six months and planned budget overruns by more than 5%. In particular, it was found that more than one-third of UAE construction projects performed poorly, with 34% performing poorly in terms of time, 34% in terms of budget and 32% in terms of quality. This approach was reasonable and quantitatively consistent (at least for schedule and cost overruns), but the outcomes were not directly comparable with other studies because those studies did not use the same definitions of poor performance.

Xiao *et al*. (2000) conducted reasonable comparisons of the performance characteristics of contractors in Japan, the UK and US, including explanations of the likely reasons for any observed differences. These comparisons were particularly useful in determining the best industry practices because these three countries are internationally renowned as world leaders in construction (Lester, 2017b; Meng, 2012; Obicci, 2017).

It was repeatedly reported that US contractors were able to complete projects significantly faster than in other developed countries, including Japan, the UK (Xiao *et al*., 2000) and Australia (Ireland, 1985). Reasons for the better performance of US contractors included the larger scale of US construction projects (economies of scale), greater simplicity and standardisation of US projects, early involvement of contractors in the project design and fewer variations of specifications and construction plans (Xiao *et al*., 2000). Although the construction time is typically longer in Japan, there is greater certainty of adherence to the planned completion schedule. Construction delays and requests to extend construction time are rare in Japan compared with the US, UK and Australia. A possible cause for this variance may be associated with differences in the allocation of construction risks to the parties of the contract, due to ethics and culture. In Japan, greater emphasis is placed on long-term relationships and mutual trust between parties, which creates greater certainty in the construction industry and potentially reduces construction risks. Industry contractors in the UK, and particularly in the US, heavily rely on prefabrication and quality control in the factory production of construction components and construction blocks. Onsite work generally suffers from a significantly lower level of care than in Japan. This may be one reason why the cost of construction in Japan is significantly higher than in the US and UK. However, Japanese clients accept this because of their expectation of the highest quality of the completed product and the absence of any budget or schedule overruns (Xiao *et al*., 2000). To date, the specific effects of cultural differences between the considered countries on construction performance have not been studied in sufficient detail. More research is needed to efficiently combine the apparent advantages of US and Japanese contractors.

In sum, it is important to note that comparing construction performance internationally is a daunting task because of the uniqueness of the products and processes involved (Demirkesen & Ozorhon, 2017). Internationally, comparative construction management research is still relatively rare but is expected to increase with the intensifying globalisation of construction industries (Adam *et al*. 2017). This research is particularly important for the development of common and internationally adopted construction performance benchmarks, which are expected to assist with the development of the urgently required standardisation of construction industries in different countries. In the construction industry, no company, or even the broader national industry, can claim to be better than others in all respects. There are always some areas in which a company or country can learn from others (Demirkesen & Ozorhon, 2017; Ramlee *et al*., 2016; Todorovic *et al*., 2015). Therefore, the development of consistent, internationally accepted benchmarks in construction performance and risk management in construction industries is essential for further successful and effective globalisation of the industry for the benefit of all countries.

The next section discusses the implications review conducted, including the identification of the significant deficiencies of the previous research methodologies. This leads to the identification of the research gaps and research questions.

2.18 Implications of the Literature Review

The review of the extensive body of literature related to risk management and risk evaluation in construction industries around the world, including the Middle East and, in particular, the UAE, demonstrates the importance and significance of this research area. This is because construction industries form the essence of broader economies and their successful and smooth development is essential for overall economic health in any country or region. Moreover, the indicated risky, complex and dynamic nature of construction industries (compared with many other areas of modern economies) presents a significant challenge to governments and company managers attempting to minimise their risks and improve the efficiency and quality of construction (Ehsan *et al*., 2010; Flanagan & Norman, 1993; Hanna *et al*., 2013; Hwang *et al*., 2017; Serpella *et al*., 2014).

A way to overcome this challenge is to have and rely upon evidence-based research outcomes that identify, clarify and properly characterise significant risks emerging in construction projects. Clear knowledge of such risks will enable and inform the development of effective mitigating strategies to reduce or eliminate the risks, thus improving project success. This makes the analysis of any risks and risk management strategies highly important for the successful development of construction industries around the world. Using incorrect or inadequate analytical methodologies may result in incorrect or unreliable findings, including inadequate characterisation of risks and poor evaluation of their importance for construction projects in a business environment (including the Middle Eastern context). This may result in inefficient or less efficient risk management and mitigation strategies, thereby causing diminished construction efficiency and reduced project success.

As indicated above, there is a large body of literature dealing with risks and risk management in construction industries (e.g., Kerur & Marshall, 2012; Rostami & Oduoza, 2017) as well as construction risks in the UAE (Al Ariss & Guo, 2016; Al Mousli & El-Sayegh, 2016; Al-Sabah *et al*., 2014; El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Faridi & El-Sayegh, 2006; Khan, 2014; Ling *et al*., 2012; Motaleb & Kishk, 2010, 2013, 2015). However, the analytical methodologies in most of the previous studies suffer from significant deficiencies, thereby raising questions regarding the validity of their findings. Therefore, previous research efforts can only be considered as the initial steps towards the detailed analysis, understanding and characterisation of construction risks and risk management practices, particularly in the Middle Eastern region (Al Mousli & El-Sayegh, 2016; El-Sayegh, 2014).

Two major general methodological approaches are typically used for risk identification and characterisation: quantitative analysis (Al-Hajj & Sayers, 2014; Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; Altoryman, 2014; El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Ghahramanzadeh, 2013; Harvett, 2013; Motaleb & Kishk, 2010, 2013; Tang *et al*., 2007; Wang *et al*., 2004, 2016; Wibowo & Taufik, 2017) and qualitative analysis (Al Ariss & Guo, 2016; Akintoye & MacLeod, 1997; Al-Hajj & Sayers, 2014; Khan, 2014; Khodeir & Mohamed, 2015 Kivrak *et al*., 2009; Ling & Hoi, 2006; Ling *et al*., 2012).

Qualitative analysis is typically based on interview data collected from a few study participants. The typically open-ended questions and semi-structured format of these interviews enables a wide range of opinions and topics to be captured and discussed, which is beneficial for the comprehensive identification of potential issues. This approach is particularly useful when little is known upfront about the potential outcomes and findings. The major drawback of qualitative analysis is its inability to provide quantitative assessments of the findings, such as levels of statistical significance, reliability and validity of outcomes, and quantitative comparisons between the risks and strengths of the risks.

The second major analytical approach is quantitative analysis, which uses statistical methods to analyse the available data on risks and risk management. Data are usually collected using a survey instrument that seeks participants' structured opinions regarding their perceptions of construction risks and/or risk management strategies (Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Motaleb & Kishk, 2010, 2013). The quantitative approach may provide better outcomes, including detailed assessments of the findings and their level of statistical significance (i.e., probabilities for the specific outcomes to be correct), reliability and validity, strengths and importance of different risks, and quantitative comparisons between risks and risk factors.

However, quantitative approaches often assume some preliminary knowledge of the expected risks and their management strategies, which is necessary to properly formulate the questionnaire items in the survey instrument. The need for preliminary knowledge of risks is a drawback of the quantitative approach. It might be difficult to properly construct a questionnaire instrument in the event of limited prior knowledge of possible risks. Therefore, a combination of qualitative and quantitative methodologies typically has significant benefits and enables the reliable identification and quantitative characterisation of risks and their management strategies (Al-Hajj & Sayers, 2014; El-Sayegh, 2014; Harvett, 2013; Leppink, 2017). In addition to this, further validation of the survey instrument is typically achieved using small pilot studies that enable validation of the questionnaire items and their clarity, adequacy and efficiency (Fink, 2003; Molina-Azorin & Fetters, 2017).

To date, the quantitative methods of analysis used to identify and characterise construction risks and their management strategies have been largely limited to basic comparisons of specific risks directly identified by individual items in the survey instrument. Different methods for such comparisons have been developed and introduced, including:

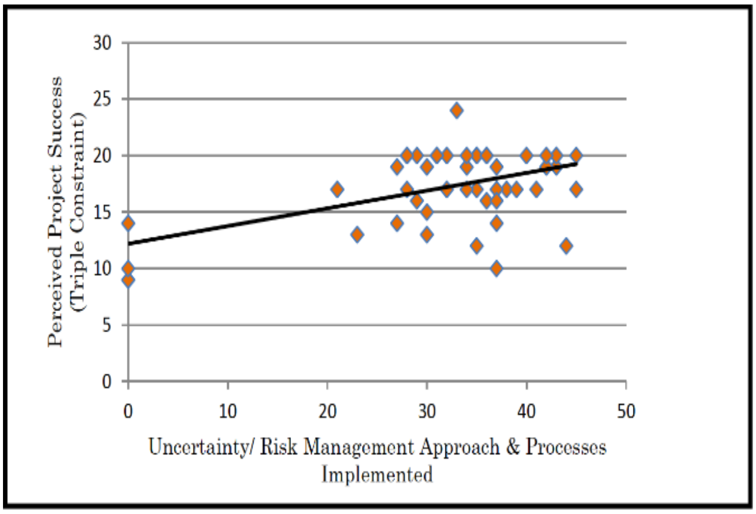
- The relative importance index and mean criticality index (Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014 Enshassi *et al.*, 2009; Motaleb & Kishk, 2010);

- The significance index score (Zou *et al*., 2007);
- Calculated response frequencies and mean scores for particular risks (Odongo *et al*., 2012);
- The Spearman correlation coefficient (Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014 Enshassi *et al*., 2009; Motaleb & Kishk, 2010);
- Direct measurements of risk-ranking by questionnaires (Kartam & Kartam, 2001);
- Weighted risk scores (Kartam & Kartam, 2001; Lyons & Skitmore, 2004);
- An analysis of variance (ANOVA) test for comparisons between different groups of participants (Lyons & Skitmore, 2004);
- Kendall's coefficient of concordance as a measure of agreement between raters (Enshassi *et al*., 2009);
- Simple linear regressions for pairs of variables (Harvett, 2013); or
- Methods of qualitative analysis based on participants' interviews (Al-Hajj & Sayers, 2014; Kivrak *et al*., 2009; Ling *et al*., 2012; Ling & Hoi, 2006).

The major drawback of these methods is that their outcomes cannot be used to establish any causal relationships between different constructs associated with risks and their management in construction industries. Analysis based on simple Spearman correlation coefficients cannot provide reliable conclusions regarding existing relationships between the variables and/or factors (see Section 3.5.2 for more detail). Further, the major reasons for using the non-parametric measure of correlation in the form of the Spearman correlation coefficient instead of the (parametric) Pearson correlation coefficient may relate to the non-normal distribution of the survey-measured variables and the ordinal nature of the variables, although these reasons have not been expressly stated (Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008; El-Sayegh, 2014).

For the same reasons, ANOVA (Lyons & Skitmore, 2004) cannot be mathematically justified for survey-measured variables typically lacking distribution normality, and the non-parametric analogue of ANOVA must be used instead. On this basis, ANOVA-based outcomes are likely to be flawed because of the strict applicability conditions for the parametric group comparison tests and because of the lack of adjustment for other measured variables (which can only be done through the development of a consistent statistical model).

The relative importance index or significance index score (Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014; Enshassi *et al.*, 2009; Motaleb & Kishk, 2010; Zou *et al.*, 2007) as well as response frequencies and mean risk scores (Odongo *et al.*, 2012), direct risk-raking and weighted risk scores (Kartam & Kartam, 2001; Lyons & Skitmore, 2004) and Kendall's coefficient of concordance (Enshassi *et al.*, 2009) do not allow any adjustments for numerous survey-measured variables or the determination of causal effects (or effect paths) between variables. This is a major shortcoming of these techniques. They are not designed to determine multiple or mutual effects of multiple variables, which makes the outcomes prone to errors and uncertainties caused by the confounding effects of multiple variables.



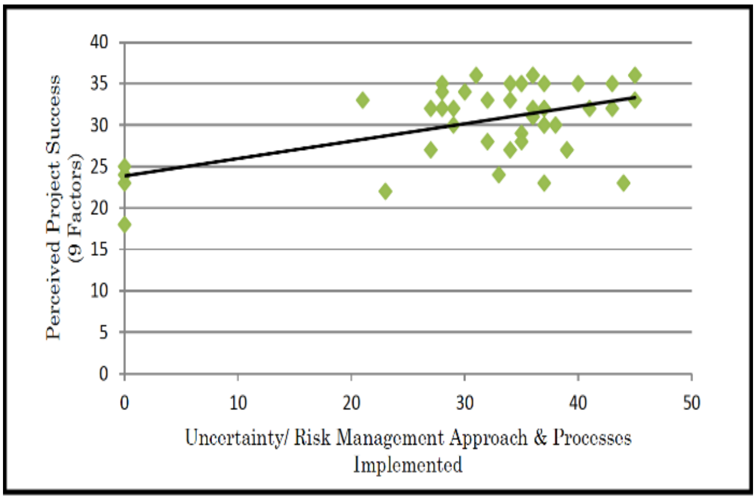


Figure 2.14: Project Success versus Uncertainly for Complex Projects

Source: Harvett (2013, p. 138-139)

Similarly, the analysis conducted by Harvett (2013) was based on the Spearman correlations and simple regressions for pairs of variables (such as the two examples in Figure 2.14). Such regressions were not adjusted for any other variables measured in the study, which was why the other variables could be significant confounders for the outcomes. This reduced the reliability of the dependences and findings (Harvett, 2013) and those findings could only be regarded as basic outcomes of summary statistics and group comparisons. The significant scatter of the data points in Figure 2.14 and the relatively low values of the correlation coefficients (< 0.3) further corroborate this proposition.

Further, the examples of the dependences shown in Figure 2.14 involve several clear outliers along the horizontal axis (at zero uncertainty). The consideration of the model fit (not presented by Harvett, 2013)—for example, in the form of quantile-quantile (q-q) plots—was likely to confirm the outlier nature of the points. Removal of these outliers was possible to significantly reduce the correlation coefficients and their significance. The analysis was also insufficient for determining and understanding any causal effect paths involving different variables, and it lacked reliable predictions, including calculated prediction intervals.

Several recent studies used more advanced and better justified statistical methodologies to analyse issues associated with construction industries. These methodologies were based on confirmatory factor analysis (CFA) and structural equation model (SEM) for the characterisation of potentially causal paths of effect between the variables and/or factors (Doloi *et al*., 2012; Chandra, 2015; Eybpoosh *et al*., 2011; Gunduz *et al*., 2017; Khosvari *et al*., 2014; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Patel & Jha, 2016; Sambasivan *et al*., 2017; Samee & Pongpeng, 2016; Xiong *et al*., 2015). Some of these studies focused on identifying and analysing risks in construction industries (Doloi *et al*., 2012; Chandra, 2015; Gunduz *et al*., 2017; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Patel & Jha, 2016; Sambasivan *et al*., 2017; Samee & Pongpeng, 2016; Wang *et al*., 2016).

Additionally, several studies used Cronbach's alpha analysis to evaluate internal consistency of risk factors and data (Altoryman, 2014; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Gunduz *et al*., 2017; Harvett, 2013; Low *et al*., 2015; Patel & Jha, 2016; Samee & Pongpeng, 2016; Wang *et al*., 2016; Xiong *et al*., 2015). However, the studies did not conduct an in-depth analysis of the consistency of each item associated with the proposed factor by removing the item from the factor and recalculating the Cronbach's alpha values (see Section 3.5.1.2 for more detail). This left a degree of uncertainty regarding the previously undertaken construction of factors related to risk management in construction industries.

A significant benefit of CFA is that it enables reasonable grouping of individual survey items into constructs (also termed as factors or latent variables), with the quantitative evaluation of the factor loadings (weights) characterising the relationships between the items and the associated construct (Bollen, 1989; DiStefano *et al*., 2009; StataCorp, 2015; Yong & Pearce, 2013). However, even if they are well formulated, the survey items can be misinterpreted and/or misperceived by participants, particularly in a culturally diverse sample of participants. Items in different survey instruments can be formulated differently, including different definitions of an emphasis on specific construction risks. This is likely to be one reason for the wide diversity and, at times, disagreement of the previous literature findings regarding construction risks and their management strategies (Khodeir & Mohamed, 2015; Musa *et al*., 2015). CFA should resolve or at least alleviate this problem by introducing and characterising (as numerical latent variables) conceptual risk factors that are calculated using an averaging procedure for the survey items associated with the factor. These factors are characterised by their numerical factor scores and can thus be considered and used as new latent numerical variables (Bollen, 1989; DiStefano *et al*., 2009; Yong & Pearce, 2013). The procedure for calculating the factor score involves multiple survey items that reflect a common aspect described by the factor. This significantly reduces the contribution of fluctuations of each individual risk (item in the survey instrument) that might be caused by misperceptions of the item, differences in risk definitions or subjective emphases of the researcher.

The major benefit of using SEM to characterise mutual quantitative relationships among multiple variables and/or factors is its ability to identify and characterise causal effect paths through mediating variables and factors (Xiong *et al*., 2015). This approach enables the determination of the total effects of exogenous variables or factors on any endogenous variables or factors, including through mediation of other endogenous variables or factors (Eybpoosh *et al*., 2011; StataCorp, 2015; Xiong *et al*., 2015).

SEM also enables simultaneous consideration of multiple mutually correlated variables, which is not usually possible in other statistical methodologies and models (Eybpoosh *et al*., 2011; StataCorp, 2015; Xiong *et al*., 2015). Consideration of mutually correlated variables is particularly important in the case of survey-based data, for which different items (measurable variables) often have natural and, at times, strong correlations with each other.

As indicated above, methodologies based on CFA and SEM have previously been used to identify and characterise risk paths in construction industries (Chandra, 2015; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Gunduz *et al*., 2017; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Sambasivan *et al*., 2017; Wang *et al*., 2016). However, the corresponding literature body is rather less in number. More importantly, none of these studies have considered risks and risk factors in the UAE construction industry or used survey questions and constructs that would adequately reflect project success and the need for risk management research in the UAE construction industry. Moreover, several studies did not consider mutual effects between the risk factors/constructs (Chandra, 2015; Gunduz *et al*., 2017; Low *et al*., 2015), the effects of risk factors on the success of construction projects or on any other constructs that would be close in nature to project success (Gunduz *et al*., 2017; Low *et al*., 2015; Wang *et al*., 2016), or they did not present sufficient justifications of the model fit (Kim *et al*., 2009; Liu *et al*., 2016).

Doloi *et al*. (2012), Eybpoosh *et al*. (2011) and Sambasivan *et al*. (2017) presented better-justified studies involving SEM and construct development using CFA and Cronbach's alpha analyses. However, they used the dependent constructs of cost overrun (Eybpoosh *et al*., 2011; Sambasivan *et al*., 2017), abandonment (Sambasivan *et al*., 2017) and construction delays (Doloi *et al*., 2012), which represented parts of the more general construct of project success. Therefore, there is a need to generalise previous outcomes and consider the effects of any risks on the general construct of project success to reflect overall success and satisfaction in the construction industry.

Another significant shortcoming of previous studies is the lack of reasonable adjustments for demographic and/or company variables within the data samples. The only attempt to involve demographic variables was undertaken by Wang *et al*. (2016), who constructed the categorical variables of age groups, education and income groups into a factor of personal rationality, while the gender variable was ignored in the SEM analysis. Unfortunately, in the absence of reasonable explanations, this approach is questionable because standard SEM does not allow for the proper consideration of categorical variables with more than two categories (StataCorp, 2015).

As explained above, the methodological deficiencies of previous studies of risks and risk management in the UAE construction industry raise significant doubts and questions about the validity and correctness of the outcomes in this area. These doubts are relevant to any types of risks (e.g., economic and cultural) that are expected to be particularly important in the UAE context. The lack of a systemic methodological approach and associated reliable findings creates significant barriers to the adequate characterisation of economic and cultural risks and risk factors in the UAE construction industry.

Therefore, the existing knowledge gaps emerging as a result of the conducted literature review are listed as follows:

- Only limited quantitative characterisations of risks in the UAE construction industry have been conducted to date;
- These risk analyses and characterisations in the UAE have been limited to basic comparisons of specific risks directly identified by individual survey items, with no causal effects between the considered variables being determined, and with no adjustments for any confounders;
- As a result, previously undertaken analytical efforts and their outcomes in identifying and characterising risk management practices and cultural and economic risks (which are expected to be particularly important in the UAE business environment) cannot be regarded as reliable or valid;
- No overarching themes or constructs/factors (e.g., cultural diversity) have been developed in the UAE to embrace different individual risks and/or risk management practices that could reasonably be associated with each factor;
- No adjustments have been made for participant and company demographic variables in any previous consideration of risk management practices, risks and risk factors in the UAE construction industry;
- No attempts have been made to determine and characterise effect paths of various risks and variables on project success in the UAE construction industry. This is particularly important for a detailed understanding of the mechanisms of mutual interactions between different risks and any possible mediation variables or factors; and
- Only limited and non-systemic attempts have been made to identify and characterise mitigation strategies in risk management in the UAE. *"There appears to be far more literature offering prescriptions to project managers about how to manage risk in projects, rather than assess the relative effectiveness of those prescriptions"* (Kutsch & Hall, 2010, p. 249).

There are four research questions arising from these knowledge gaps are considered as follows:

1. What are the major risks and risk factors (including any cultural and economic risks) and what are their effects on UAE construction projects?

2. What are the major risk management practices in the UAE construction industry and what are their effects on project success and management?
3. What are the effects of demographic and company variables on project success in the UAE construction industry?
4. How can risk management practices in UAE construction projects be improved?

These research questions have led to the development of the research objectives of this thesis, which were presented in Section 1.4 of Chapter 1. In addition, the research questions presented above aims to undertake detailed quantitative and qualitative analyses of risks and risk factors in the UAE construction industry, risk management practices and possible improvements in the specific environment of the UAE, and the development of practical recommendations for better management of risks and greater success of construction projects. Due to the nature of the aims and research questions presented above, this study is not investigating a general or decontextualised theory of the relationship between project management, risk, risk management, culture, economic and project success, but are developing a contextual account of the relationships in the case of UAE. The methodology section to achieve the above aims is presented in the next chapter.

2.19 Conclusion

As explained above, construction industries form the essence of broader economies and their successful and smooth development is essential for overall economic health in any country or region. This makes risk management a highly important managerial strategy in any modern construction project, which highlights the significance of this study for economic development in the modern world.

This chapter examined the extensive body of literature related to the overview of the UAE, culture in Arab and Western countries and an evaluation of the UAE construction sector. This chapter has reviewed the literature on project and management, construction projects, history of risk management, definition of risk, risk in construction projects and risk management processes and sub-processes. It has also reviewed and examined related studies of other researchers and their findings to underline the factors influencing the risk management process, classified construction risks and discussed economic and cultural factors at the national level as well as the criteria for successful construction projects. Furthermore, this chapter has identified the most significant risk factors in various countries and causes of delays in construction projects and comparison of construction performance in UAE and other countries.

Finally, this chapter discussed the detailed implications, reviewed and identified significant gaps in the knowledge and concluded by with the research questions.

Chapter 3 will detail the aims and research questions and the research methods and approach used in this thesis as well as the research design and how the data were collected and analysed.

Chapter 3: Research Methods

3.1 Introduction

This research explores risk management practices in UAE construction projects. The previous chapter reviewed the relevant literature and introduced the concepts of risk and risk management in construction projects. It continued by analysing the findings of other related studies around the world, in the Middle East and in the UAE in order to demonstrate the importance and significance of the research area and leading to the research questions. This chapter presents the aims and research questions in detail. The nature of the techniques and methods that are needed to achieve the aims and objectives and the means by which the posed questions in this thesis will be answered is presented. The general mixed methodology of quantitative and qualitative will be used to describe, elaborate and explain the requirements of the research topic involved.

For this research, it will be necessary to apply survey procedures and statistical including mathematical approaches. The nature of this study means that a qualitative method will also be involved. Important sampling procedures will need to be considered to make it possible to select the appropriate sample and collect data to effectively analyse the responses to find answers to the research questions (Clough & Nutbrown, 2012; Grbich, 2013). Finally, ethical considerations are considered as per ethics approval.

3.1.1 Aims and Research Questions

The implications of the literature review summarised the gaps in the literature as identified at the end of the previous chapter. Using this as a basis, this section develops in detail the main aim and research questions.

The research aim of this study is to conduct detailed quantitative and qualitative analyses of risks and risk factors in the UAE construction industry, risk management practices and possible improvements in the specific environment of the UAE and the development of practical recommendations for better management of risks and greater success of construction projects. To achieve this aim, this thesis has the following four research questions:

1. What are the major risks and risk factors (including any cultural and economic risks) and what are their effects on UAE construction projects?

2. What are the major risk management practices in the UAE construction industry and what are their effects on project success and management?
3. What are the effects of demographic and company variables on project success in the UAE construction industry?
4. How can risk management practices in UAE construction projects be improved?

To achieve the main aims and research questions, this research uses a combination of quantitative and qualitative methodology. A survey type method will be the main source of data for the quantitative analyses, while the in-depth interviews conducted using a sample of the UAE construction project personnel will form the basis for the qualitative analyses. This chapter will also report on the need to develop some of the constructs that are associated with risk management in construction projects in the UAE for the purposes of data analysis.

This section describes the data collection techniques, the survey measurement instrument, the participants of the study, the data sample estimates, the dependent and independent variables and the statistical models employed in this thesis. It also outlines the statistical methodologies for the exploratory and explanatory analyses used to construct the relevant factors (statistical constructs) and provide a comprehensive evaluation and quantitative characterisation of the significant relationships between the variables and constructs.

The analytical methodologies employed include exploratory and confirmatory factor analyses (for construct determination), Cronbach's alpha analysis (to investigate the internal consistency of the identified constructs), structural equation models (SEMs) and generalised SEMs for the determination of the direct and indirect effects of the variables and constructs on project success (Chandra, 2015).

As noted earlier, this study also uses qualitative investigative approaches, including interviews, so the coding of the data will be essential and will require a particular method. A tool known as NVivo 11 was used in this study and is described and explained in this section. The nature of the NVivo 11 analysis will include qualitative identification and characterisation of the trends and/or constructs associated with risks and their management in the UAE construction industry.

3.2 Research Method Design

In the research design stage, the researcher chooses methods which influence the way he or she collects and analyses the data that, in turn, will influence the outcome of the research. This chapter explains how those choices were made for this research and how the data was subsequently collected and analysed, using both quantitative and qualitative methods.

The first step in the research process is to identify the area of research and create the research questions as done based on the gaps identified in the literature review (Novikov & Novikov, 2013). The research strategy should be chosen along with the techniques for data collection and the research design (Novikov & Novikov, 2013). The data is then analysed and interpreted, leading, if all goes well, to conclusions (Ratner, 2013).

The research method refers to the technique used to collect data, which may include particular instruments such as questionnaires and structured interviews (Mills & Birks, 2014; Leicht *et al*., 2010). Researchers who argue for a quantitative approach state that distinct cultural levels are embedded in distinct methods, while those who argue for a qualitative approach state that this approach makes it possible to investigate the most profound cultural levels (Leppink, 2017).

The mixed-methods research is defined as an approach whereby "*a researcher or team of researchers combine elements of qualitative and quantitative research approaches (for example, use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purpose of breadth and depth of understanding or corroboration*" (Johnson *et al*., 2007, p. 123). According to Johnson and Onwuegbuzie (2004), mixed-methods research is a "*class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study*" (p. 17). This approach makes it possible to address wider research questions (Molina-Azorin, 2016). Advantages of this method include the following (Almalki, 2016):

- Using only one method generates results that suggest questions that need to be addressed by another method;
- One method can be used to generate data that reinforces the data generated by another method;
- One method can be used to cancel or neutralise biases in the results generated by another method; and
- The researcher can integrate the resulting quantitative and qualitative data into a single, more extensive database.

Taking into account the nature of the aims and objectives and research questions, this thesis uses a mixed-methods approach to obtain empirical evidence of risk management practices in the UAE construction sector by exploring stakeholders' practices and perceptions. In addition to this, the research process also involves organisations and people, so that issues such as organisational culture and people's mentality (bounded rationality) play a dominant, though intangible, role.

Using both methods makes it possible to take into account both quantifiable data, such as statistics, and frequency-related qualitative data in addition to less quantifiable mostly subjective data such as an individual's knowledge and experience. Using mixed methods allows the researcher to draw on the strengths and minimise the weaknesses of each method (Johnson & Onwuegbuzie, 2004). It enables the researcher to answer questions that could not be answered using other methodologies (Leppink, 2017).

Because questions can be approached from different perspectives, the mixed-methods approach provides alternatives and creates an opportunity to present a greater range of divergent views (Molina-Azorin & Fetters, 2017). As there has been relatively little in-depth research focused on construction stakeholders' practices and perceptions in the UAE, this study aims for both breadth and depth in its findings. This aspect is more likely to be achieved with a mixed-methods design than with the use of any single method (Molina-Azorin & Fetters, 2017). In fact, mixed-methods research has already proven to be an ideal approach for developing innovative theoretical perspectives in risk management and construction research (Strang, 2015).

According to Creswell (2013), mixed-methods is one of the three major research paradigms: qualitative followed by quantitative; quantitative followed by qualitative, or simultaneously conducting both. The quantitative questionnaire was developed and administered to the study participants as the first sequence in this research because that questionnaire was based on the extensive existing literature on risks and their management in the construction industries all over the world. Also, the rationale of conducting the quantitative questionnaire first in this study is to use qualitative results to assist in explaining and interpreting the findings of quantitative data. As will explained and discussed in more details in Sections 6.1 and 6.4, the qualitative analysis was used to further corroborate the outcomes of the quantitative analysis and check for completeness of identification and characterisation of the significant risk factors in the UAE construction industry (including any possible ways to expand the quantitative outcomes).

3.3 Mixed-Methods Design: Questionnaire and Interviews

3.3.1 Quantitative Approach: Questionnaire

Questionnaires have been frequently used to assess and analyse data in the field of risk management (e.g., Al-Hajj & Sayers, 2014; Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; Altoryman, 2014; El-Sayegh, 2008, 2014; Ghahramanzadeh, 2013; Harvett, 2013; Tang *et al.*, 2007; Wang *et al.*, 2004, 2016; Wibowo & Taufik, 2017). A questionnaire can have any number of questions, depending on the topic, the respondents' characteristics and the time needed to complete it (Creswell, 2013).

The following criteria apply to the construction of a questionnaire (Denscombe, 2014):

- Use simple and clear vocabulary;
- Avoid sensitive questions;
- Avoid leading questions;
- Maintain the logical flow; and
- Ensure each question is related to the topic.

A questionnaire can include open-ended or closed-ended questions. This study uses the latter to structure a multiple-choice questionnaire. The advantages and disadvantages of questionnaires with closed-ended questions are summarised below (Creswell & Plano Clark, 2011; Rahman, 2016).

- Advantages:
    - It is easy to analyse and compare the responses;
    - The results can be presented in the form of statistics, graphs and tables; and
    - Both the questions and the answers may be standardised.
- Disadvantages:
    - Valuable information and insights may be missed because the respondents cannot express themselves completely; and
    - The researcher cannot always be sure a respondent has understood a given question or statement. The respondent may, in fact, have misinterpreted it.

Section 3.4 discusses the quantitative approach in more detail in how questionnaire was developed and how survey data was collected and analysed.

3.3.2 Qualitative Approach: Interviews

Like questionnaires, interviews have been frequently used to assess and analyse data in the field of risk and risk management involving construction projects. Wang and Chou (2003) examined risk allocation and risk-handling in Taiwanese highway projects while Cruz *et al*. (2006) investigated the downside risks in construction projects developed by the Spanish civil service. Tang *et al*. (2007) studied risk management in the Chinese construction industry from the participants' perspectives while Hassanein and Afify (2007) investigated how contractors view risk identification and management in Egypt. Moreover, Perera *et al*. (2009) researched risk management in road construction in Sri Lanka while Khodeir and Mohamed (2015) studied the political and economic risk factors affecting construction projects in Egypt. Evidently, the various interview methods are used widely in the literature and are considered a sound qualitative method of data collection.

A research interview can be structured, semi-structured or unstructured (Gill *et al.,* 2008). These types vary in the degree to which the researcher directs the interview and in the length of the respondents' answers. Interview types include face-to-face interviews, group interviews and focus groups (Denscombe, 2014), with qualitative researchers generally favouring the face-to-face format for semi-structured and in-depth interviews (Creswell & Plano Clark, 2011; Fontana & Frey, 1994; Irvine *et al.,* 2013; Knox & Burkard, 2009; Oltmann, 2016; Ryan *et al.,* 2009; Sturges & Hanrahan, 2004; Yin, 2013).

The advantages and disadvantages of interviews as a research method include the following (Creswell, 2013; Denscombe, 2014).

- Advantages:
    - The researcher can typically get a high response rate;
    - As an interviewer, the researcher has control over the interview;
    - It is easier for both the interviewer and the respondent to explain what they mean;
    - The researcher can gather information in more detail and greater depth;
    - The tools required, such as tape recorders, are inexpensive and easy to use; and
    - The skills needed, such as taking notes, are easy to learn.
- Disadvantages:

- Analysis of data from interviews can be time-consuming;
- Researcher cannot count on getting standard responses;
- Data collected from the interviewees' responses can be affected by the researcher's own skill (or lack of skill) as an interviewer;
- The recording process may cause the interviewee to postpone or delay his or her responses;
- Interviewees may view the interview as an invasion of privacy and/or they may conceal information; and
- Interviews can be costly and/or time-consuming if the interviewees live somewhere far away or in a difficult to reach location.

In this study, semi-structured, face-to-face interviews are used in order to gain a deeper understanding of people's knowledge, experience, opinions. The interview will allow some open discussion of the similarities and dissimilarities of viewpoints of participants regarding the risks of construction projects in the UAE. In this case the study involved the following preparatory steps:

- Designing the semi-structured questions;
- Obtaining the interviewees' authorisation;
- Preparing the notes and audio recorder; and
- Letting the interviewees know how long the interview will take.

Section 3.6 discusses the qualitative approach in greater detail; in particular, how interview data were collected and analysed.

The studies reviewed above-investigated construction risk and the risk management process in various countries and from various participants' points of view. They, therefore, used a variety of data collection methods, with the most frequently used items being questionnaires and interviews. These methods are well established in the literature and are able to allow the researcher to investigate an individuals' knowledge, experience and opinions. With those studies and their data collection methods in mind, Sections 3.4 and 3.6 discuss the data collection methods used in this study.

3.4 Data Collection: Quantitative Approach

The data collected for the quantitative analysis in this study was a type of cross-sectional data that was obtained by surveying the study participants. Cross-sectional data (as opposed to longitudinal data) are collected within a relatively short period of time, so that the time-dependence of effects need not be taken into account (Almalki, 2016; Bryman, 2004). Such data is therefore suitable for analysing trends associated with risk management in the UAE construction industry at the time the data was collected, but not the evolution of those risks over time. This should be regarded as one of the study's limitations.

3.4.1 Measurement Instrument

The primary instrument for data collection was an online analytical survey created using the Qualtrics Survey Software. Data was collected from clients (who is a governmental body in this thesis), contractors and consultants involved in all construction projects in the UAE (these three categories are discussed in more detail in Section 3.4.2). A copy of the survey is presented in Appendix 4.

The Qualtrics tool was used both to collect the data and to help with the data analysis. Qualtrics allows the researcher to

- See the results as soon as they are collected, view live graphs and charts and apply filters to the results;
- Analyse an individual's responses;
- Save the results as a PDF to examine offline or to distribute as a hard copy;
- Create a public link to the survey results, which can be password-protected;
- Present a summary of the results in various formats; and
- Keep all collected data absolutely private and secure.

The development and validation of the survey questionnaire were based on the following considerations:

1. The literature on risk management and construction project development was analysed to identify previously validated questionnaire instruments for measurements of the variables and constructs relevant to this study. The instruments identified were adapted for this survey;
2. Three risk management experts were engaged to ensure that the instrument sufficiently

characterises the major factors and variables that might affect construction project success; and

3. A small pilot study was conducted to check the instruments' clarity, adequacy and efficiency (Fink, 2003; Hwang *et al.,* 2014; Molina-Azorin & Fetters, 2017).

The survey was divided into the following parts:

- Items Q1–Q16 requested information about the interview's professional role and experience in order to compare the respondents and their responses. This information included job title, gender, level of education, approximate years of experience in the construction industry, project management and risk management, formal training in risk management practices, and whether they had worked outside the UAE. The job title was subdivided into three categories: client, contractor and consultant (this will be discussed further in Section 3.4.2);

- Items Q17–Q28 requested information about the respondent's company: its profile, key activities, interactions within the risk management team, number of expert risk managers, approaches to risk management and decision-making processes. The items about risk management and decision-making processes were adapted from Ghahramanzadeh (2013) and Harvett (2013);

- Items Q29.1–Q29.15 reflected the major construction risks defined in Al Harthi (2015), Ghahramanzadeh (2013) and Wang *et al.* (2004, 2016) and were specifically adapted for this study of the UAE construction industry. A table listed and briefly described 15 risks and asked the respondent to rate how critical they were on a 1–5 Likert scale (low to high). The risks categories were changes in law, corruption, environmental protection, site safety, cash flow, cultural differences, HR, foreign exchange and convertibility, inflation and interest rates, cost overruns, inadequate design, low construction productivity, late payment, inadequate project management and market demand;

- Items Q30.1–Q30.14 and Q32 explored the major economic risks in the construction industry (Al Harthi, 2015; Ghahramanzadeh, 2013; Wang *et al*., 2004, 2016);

- Items Q31.1–Q30.19 and Q33 examined the major cultural risks of doing business in the UAE. These were adapted from Al Harthi (2015) and Ghahramanzadeh (2013) to apply to the UAE construction industry; and

- Items Q34–Q40 evaluated the company's risk management processes and project success. These were adapted from Ghahramanzadeh (2013) and Harvett (2013).

As explained above, adapting questionnaire items from survey instruments already validated by other research groups (Al Harthi, 2015; Ghahramanzadeh, 2013; Harvett, 2013; Wang *et al*., 2004, 2016) ensures the validity of the measurement instrument used in this study. Additionally, the pilot study further corroborated the instrument's validity and efficiency by testing it with a smaller sample (five contractors, two clients and three consultants) that was selected in the same way and from the same pool as the main participant cohort. The pilot study participants were asked to make comments and/or suggestions in relation to the following issues (Eldridge *et al.*, 2016):

- Clarity of the survey questions;
- Relevance of the survey questions;
- Overall design of the questionnaire; and
- Time needed to complete the questionnaire.

These comments and suggestions were taken into account in the final amendments to the questionnaire and the instructions issued to participants.

Most of the questionnaire items evaluated risks and risk management in the UAE construction industry on 1–5 Likert scale. Q35 and Q38–Q40 were on a 1–4 scale, Q23 and Q27–Q28 were on a 1–3 scale, and Q24 and Q36–37 were 'yes-or-no' type questions. While the variables on the 1–4 Likert scale were still considered (approximately) numerical variables and the respective factors (constructs) were constructed (see Sections 3.5.3.1 and 3.5.3.2 for more details), the variables on the 1–3 scale and the yes-or-no variables were considered as categorical variables.

3.4.2 Study Participants

As discussed in Chapter 2, while a construction project may involve any number of parties, the main parties are generally the client, contractors and consultants, who are therefore the potential study participants chosen for this study. These parties are defined as follows:

- *Client:* A responsible legal person who signs the construction contract and assigns its activities to contractors in accordance with the contract's documents. Clients invest in and fund construction projects. The client's objective is to have the project delivered on time, within budget and fit for purpose;

- *Contractor:* A responsible legal person who, by signing the construction contract, takes responsibility for construction activities. Contractors undertake the work of constructing a building or any other type of construction. The contractor's objective performing under the contract is to make a profit; and
- *Consultant:* A responsible legal person introduced to the contractor by the client in order to supervise the execution of the work with whatever authority is granted in the contract. Consultants are hired to use their professional skills and experience to protect the client's interests, and they are designers, project managers, quantity surveyors and specialist engineers (civil, mechanical, structural, electrical, etc.). They advise the client on most aspects of the project, including design, budget and contracts. They must also manage their own risks and protect themselves from disputes or lawsuits due to defective advice or work (Ghahramanzadeh, 2013; Nasirzadeh *et al.*, 2016).

Apart from selecting the participant from these three groups, some other points were considered about the projects they had done or were executing at that moment:

- Parties who were involved in governmental projects (public sector) and private sector;
- Parties involved in various types of project in public and private sector such as civil construction, industrial and commercial buildings, residential buildings, highways and utilities; and
- Parties involved in construction projects of different cities in UAE in order to cover various regions as much as possible and evaluate the specific risks which may be more influential in the projects according to the specifications of their location. Cities were Abu Dhabi (capital), Ajman, Dubai, Fujeirah, Sharjah, Ras al-Kheimah and Umm al-Quwan.

These three entities may, in turn, include specialists such as superintendents, project managers, subcontractors, quantity surveyors and technical managers. For this group any of them may play a part in one phase or another depending on the type of project, the type of procurement system and the type of contract (Nasirzadeh *et al*., 2016; Peckiene *et al*., 2013).

3.4.3 Collection Process

The survey was made available online to potential participants though the Qualtrics Survey Platform. Participants had to be at a senior management level in their organisations to make reasonable judgements on the risks associated with construction projects and on the strategies and/or mitigating factors used to manage and alleviate those risks. Therefore, only high-level and middle-level managerial and technical engineering staff were eligible.

The formal recruitment process in this study included the following steps. Construction companies and companies associated with construction in the UAE were identified through Internet searches and analysis of UAE government databases and registries. The HR managers of the identified companies were contacted via email with a request to identify possible study participants from their company's management and engineering staff. The HR managers were provided with information on how to access the online survey and with electronic copies of the following documents:

- *Invitation letter*: This letter invited potential participants to take part in the study. It explained that participation was voluntary and that one could withdraw one's participation at any time and without explanation. The letter asked participants to return (either online or by post) the enclosed voluntary consent form and the completed questionnaire. (The invitation letter is shown in Appendix 2.)
- *Voluntary consent form:* This document requested the participant's consent to take part in the study. The participant was asked to print his or her name, sign the form and return it to the researcher together along with the questionnaire. (The voluntary consent form is shown in Appendix 3.)
- *Participant information sheet*: This document provided details about the nature and scope of the project, including its title, a brief project description, its duration and a short explanation about the interviews. It also explained how confidentiality would be maintained. (The participant information sheet is shown in Appendix 4.)

The HR managers were asked to distribute the information about accessing the survey online and the copies of the accompanying documents amongst eligible participants. In addition to this formal recruitment process, given that the author is from the region, the author of this thesis used a number of personal contacts, to generate wider awareness of the study through 'word of mouth'.

An estimated 650 participation requests were distributed. Since all the participants knew English, the survey was given in English and there was no need to translate it into Arabic. The survey data was collected early September 2016 to late February 2017. This study received 237 valid responses, with 33 from clients, 148 from contractors and 56 from consultants. This large enough representative sample provided a sound basis for the survey analysis aspect of the study.

3.4.4 Sample Size

The sample size required for statistically significant outcomes depends on the type of statistical modelling employed. As the goal of this study is to evaluate construction risks in the UAE and determine efficient means for mitigating them, the analysis will primarily be based on CFA and generalised structural equation modelling (GSEM). (These are discussed further in Sections 3.5.1.3 and 3.5.3.) For such models, there is a rule of thumb requiring five to 10 observations (study participants) for each relationship between any two numerical variables determined on a Likert scale (Barclay *et al.*, 1995; Marcoulides & Yuan, 2017) and for each category of each categorical variable, with the exception of the base category (Barclay *et al.*, 1995; Marcoulides & Yuan, 2017).

Because the questionnaire has about 100 items, if all of these variables are simultaneously involved in a GSEM statistical model evaluating the available database, the minimum sample size should be around 500 participants. As the actual sample of 237 fell significantly short of that number, it was not possible to develop an overall model simultaneously involving all the variables defined by the survey items. It was, therefore, necessary to group the survey items in order to derive useful conclusions and findings in this study.

One way to achieve this was to develop constructs associated with groups of survey items relevant to the same significant aspect or risk factor. Such a construct can then be characterised by its factor score and be considered as a numerical latent variable. As a result, one latent variable characterised by its factor score could replace a number of survey items associated with it, drastically reducing the number of variables in the model (Bartholomew *et al.*, 2011; Yong & Pearce, 2013).

For example, at least eight items—namely, Q31.6–Q31.10, Q31.18, Q34.3 and Q34.9—could be associated with what could be termed ‘communication’. Therefore, using CFA modelling, it is possible to establish quantitative links between the construct of communication and these eight survey items (measurable variables). Once these relationships have been established, there is no longer a need to consider the indicated survey items, just the new latent variable, communication, characterised by its numerical factor score obtained from CFA (see Section 3.5.1.3 below for more detail). Thus, the latent variable could replace eight measurable variables in the final GSEM model.

It is, therefore, argued that the available sample size of 237 observations (study participants) is sufficient for the expected statistical modelling as long as the survey items are reasonably grouped and replaced (where possible) by constructs (latent variables) describing a particular risk or mitigating/exacerbating factor. The goodness-of-fit (GOF) indices (Appendix 5) further corroborate that this study's sample size is sufficient. These indices were calculated for each model, as GOF indices provide information about the sufficiency (or lack thereof) of model fit caused by a variety of factors, including sample size. As will be noted in Chapter 5, a sample of 237 was indeed sufficient to achieve statistically significant conclusions and findings. Moreover, since none of the GSEM models developed in this study (see Chapter 5) contain more than 20 relationships, the required sample size for these models should be around 100 to 200 participants (StataCorp, 2015), which is within the available sample of 237 participants of this study.

It is important to note that the approach based on latent variables as new numerical variables characterised by their factor scores is a reasonable approximation, given the limited sample size and reasonable computational efficiency. In this approximation, the measurable variables (survey items) associated with the constructs are only used to calculate the respective factor scores. This can be understood as a kind of averaging of the associated survey items to obtain a mean factor score (see Section 3.5.1.3 below for more detail).

3.5 Method of Data Analysis (Statistical Analysis)

This study used the Stata14 software package (StataCorp, 2015) to conduct the statistical modelling and data analysis because it was capable of GSEM modelling. GSEM was essential because there were several significant categorical variables whose analysis was not possible in the standard structural equation modelling approach (StataCorp, 2015).

3.5.1 Factor Analyses

As explained above in Section 3.4.1, the survey design had already been validated by other researchers. Different sections of the questionnaire were based on recommendations of findings in the literature (Al Harthi, 2015; Ghahramanzadeh, 2013; Harvett, 2013; Wang *et al.*, 2004, 2016). This was mainly to characterise different types of risk in the UAE construction industry. In many cases, several questionnaire items may be attributed to the same risk. For example, as explained above in Section 3.4.4, eight items may be perceived as associated with one risk construct, communication.

However, such a perception may be inappropriate and, in any case, the work must be confirmed mathematically, including the determination of any quantitative relationships between constructs (latent variables) and their associated items (measurable variables). The statistical confirmation of any perceived constructs and their quantitative association with the respective items was achieved using (a) exploratory factor analysis (EFA) for the preliminary identification of possible factors (constructs); (b) Cronbach's alpha analysis for the evaluation of their internal consistency; and (c) confirmatory factor analysis (CFA) for the final determination of the identified constructs and their quantitative relationships with the associated questionnaire items (Bartholomew *et al.*, 2011; Goodboy & Kline, 2017; Hoe, 2008; Iacobucci, 2010; Rahmadi *et al.*, 2017; Trizano-Hermosilla & Alvarado, 2016; Yong & Pearce, 2013).

There are two reasons for using factors (or constructs) in this study. First, introducing factors as latent variables makes it possible to significantly simplify the modelling; that is, by reducing the number of variables. Second, identifying the factors that are associated with risks in the construction industry is conceptually beneficial. This is because there are many specific risks, which researchers often formulate (typically, as questionnaire items) in accordance with their own perceptions or with specific companies, types of construction project, countries, legal frameworks, environmental and business conditions and so on (Adams, 2008; Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016; Dey, 2009; El-Sayegh, 2008, 2014; Ghahramanzadeh, 2013; Grace, 2010; Ling & Hoi, 2006; Ling *et al.*, 2012; Motaleb & Kishk, 2013, 2015; Oztas & Okman, 2004; Zou *et al.*, 2007).

It can be a daunting task to derive a general understanding and common trends from such a multiplicity. Deriving constructs on the basis of questionnaire items associated with a common aspect or concept characterising the construct (Yong & Pearce, 2013) is likely to be of great help in understanding the general trends in risk management. The focus is shifted from a particular questionnaire item, which could be formulated or focused in a variety of ways, onto a much more general and conceptual construct with which it is associated.

To elucidate, consider again the communication construct (Figure 5.11 in Chapter 5). The eight questionnaire items associated with it could have been formulated differently. Other items might also have been perceived as associated with communication and therefore included. Such changes would alter the construct, but because constructing a construct is somewhat similar to averaging the associated items (see Section 3.5.1.3), such alterations are typically much weaker than the corresponding alterations of the associated items.

In addition to this, the communication construct reflects the general concept of communication (common to all its associated items) and how that affects project success. Using this construct as a latent variable therefore allows us to consider the general impacts and trends in risk management associated with the general concept of communication. This is opposed to the specific communication aspects (associated with the items), which are highly prone to a variety of perceptions, analytical biases and subjective judgements.

3.5.1.1 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is typically applied to determine the number of factors that might influence the measurable variables (survey items) and to identify which are associated with each other or 'go together' (Yong & Pearce, 2013). Thus, the first step in determining constructs related to risks in the UAE construction industry was to apply EFA to the survey data (Adachi, 2016; Fabrigar & Wegener, 2011; Yong & Pearce, 2013). EFA was applied to any group of questionnaire items that could be perceived as being associated with a particular construct. As a result, the perceived groupings were either confirmed or corrected.

The standard factor analysis model involves p measurable variables, $X_1, X_2, X_3, \ldots, X_p$, and m related factors (latent variables), $F_1, F_2, F_3, F_4, \ldots, F_m$. Each measurable variable is represented as a linear combination of these factors (Adachi, 2016; Yong & Pearce, 2013):

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + e_j, \qquad (3.1)$$

where $j = 1, 2, 3, \ldots, p$; $a_{j1}, a_{j2}, \ldots, a_{jm}$ are the factor loadings and e_j is the specific or unique factor. The factor loadings determine the contributions of the variables to the factor. The larger the factor loading, the greater is the association of the variable with the factor.

The square of the factor loading equals the variance of the variable explained by the factor (Adachi, 2016; Yong & Pearce, 2013).

- The first factor is typically chosen to account for the maximum of the total variance (the sum of all the variances) of the standardised observable (measurable) variables;
- The second factor is then chosen to account for the maximum of the remaining (still unaccounted) total variance of the observed variables, and so on; and
- The factors will thus have progressively less importance in the description of the observed variables (Stegmann, 2017).

The number of factors needed is typically determined by the Kaiser criterion (scree test/scree plot) or Jolliffe's criterion (Adachi, 2016; Jolliffe, 1972; Kaiser & Rice, 1974). For example, according to the Kaiser criterion, only those factors are retained whose eigenvalues (the amount of variance explained by that factor) are greater than or equal to 1. Another criterion is based on Jolliffe's criteria and this approach recommends retaining all the factors above 0.70 (Adachi, 2016). Therefore, Yong and Pearce (2013) *"suggested to use the scree test in conjunction with the eigenvalues to determine the number of factors to retain"* (p. 85).

As a result, one of the EFA outcomes was the suggested groupings of the questionnaire items in accordance with their factor loadings (Kaiser & Rice, 1974; Norris & Lecavalier, 2010; Stegmann, 2017; Stevens, 2012). However, it is important to note that EFA, being only an exploratory statistical technique (Yong & Pearce, 2013), can only indicate the factor groupings of the available measurable variables. Therefore, the groupings obtained from the EFA analysis need further corroboration and confirmation through other methods, including Cronbach's alpha analysis and confirmatory factor analysis.

3.5.1.2 Cronbach's Alpha Analysis

Like EFA, Cronbach's alpha analysis is an exploratory statistical approach for evaluating the internal consistency of factors (constructs) (Almehrizi, 2013; Cortina, 1993; Cronbach, 1951). Its use in this study was twofold.

First, the values of Cronbach's alpha increase with increasing mutual correlations between the items associated with the factor (Almehrizi, 2013; Cortina, 1993; Tavakol & Dennick, 2011). The strength of such correlations is a measure of the extent to which the associated items reflect the common property or concept characterising the factor. Therefore, Cronbach's alpha is regarded as a measure of a construct's internal consistency (Cortina, 1993; Miller, 1995; Stegmann, 2017; Wolf *et al.*, 2013). Larger values mean greater internal consistency.

A rule of thumb is that Cronbach's alpha should be larger than 0.7 for a factor to have good internal consistency and reliability and larger than 0.6 for sufficient consistency (Nunnally, 1967, 1978; Nunnally & Bernstein, 1994; Pallant, 2013; Peterson, 1994; Serbetar & Sedlar, 2016). At the same time, these might only be *indications* of a factor's internal consistency, because Cronbach's alpha increases with the number of items associated with the construct (Stegmann, 2017). The constructs with fewer associated items could be sufficiently consistent even with a Cronbach's alpha below 0.6. Cronbach's alpha should therefore be used with caution.

Second, because Cronbach's alpha tends to decrease with a decreasing number of internally consistent items in the construct (Stegmann, 2017), it should be reduced by the removal of any such consistent item.

Therefore, the following procedure was used to further evaluate the items in a construct. First, calculate Cronbach's alpha for the construct. Then, remove one of the associated items and recalculate Cronbach's alpha. If the new value is lower, then the item that was removed is internally consistent with the construct and should not be removed. If the new value is larger, then the item that was removed is inconsistent with the construct and its removal was justified.

This procedure was repeated for all items in each construct to ensure consistency and reliability. Any items whose removal caused a significant increase in the value of Cronbach's alpha were removed from the constructs. It is again important to note that this is an exploratory technique that only *indicates* whether or not a particular item is consistent with the construct. Therefore, although exploratory outcomes and indications are worth taking into account, the final determination of the validity and quantitative relationship of a construct’s associated items should be confirmed and validated using CFA (Levine, 2015).

3.5.1.3 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is the final step in the construction and validation of constructs using survey items. The development of a CFA model typically uses modification indices (StataCorp, 2015). The modification indices in Stata14 simplify the development of a suitable CFA model by offering options for improving the model by adding relationships and/or covariances. Typically, an extensive investigation of a number of similar CFA models for the same construct should be undertaken, based on the trial-and-error method, in order to find a model that has the best fit with the available data.

Evaluation of model fit for a CFA model is a complex task involving the evaluation of different aspects of the model using several tests (Bustamante & Chacon, 2016; Hooper *et al.*, 2008; Schermelleh-Engel *et al.*, 2003; Wolf *et al.*, 2013). Each such test is associated with the determination of a goodness-of-fit (GOF) index, of which six are most commonly used: χ^2-statistic, root mean square error of approximation (RMSEA), standardised root mean square residual (SRMR), comparative fit index (CFI), Tucker-Lewis index (TLI) and coefficient of determination (CD) (see Appendix 5).

One aspect of CFA modelling is that the survey items are regarded as dependent variables depending on the factors (latent variables); see Equation 3.1. Therefore, one of the applicability conditions for CFA analysis is that the dependent variables (survey items) must be distributed normally. However, the numerical variables moulded by the survey items are often not normally distributed. To enable valid CFA analysis in this case, the asymptotic distribution-free method was used in this study, which allows for the involvement of dependent variables with non-normal distributions (Bustamante & Chacon, 2016; Xiong *et al.*, 2015).

As explained at the beginning of Section 3.4.4, the CFA modelling was primarily aimed at developing new latent numerical variables characterising risks and their management in the UAE construction industry. These latent variables are factors characterised by their numerical scores. There are different ways to calculate factor scores in CFA modelling (DiStefano *et al.*, 2009; Marcoulides & Yuan, 2017). Each survey item *Q* based on a Likert scale is a numerical measurable variable having values corresponding to the answers given by the study participants. The simplest but rather crude approach to obtaining the factor score is to average all the associated items for each study participant. A better way is to use the weighted average of the associated items, where each variable has a weight equal to its factor loading. For example, the weighted average of the eight items making up the communication factor score can be calculated as:

$$C_{Com} = \frac{w_{31.6}Q_{31.6} + w_{31.7}Q_{31.7} + ... + w_{31.10}Q_{31.10} + w_{31.18}Q_{31.18} + w_{34.3}Q_{34.3} + w_{34.9}Q_{34.9}}{w_{31.6} + w_{31.7} + ... + w_{31.10} + w_{31.18} + w_{34.3} + w_{34.9}}, \quad (3.2)$$

where *w* is the factor loadings.

This equation explains the basic nature of the factor scores. The specific 'built-in' approaches to determining factor scores can differ amongst statistical software packages but their principal nature is always a weighted average of the associated items. In this study, Stata14 software was used to calculate scores for any factors associated with risks in the UAE construction industry and Equation 3.2 is used as a guide for understanding the mathematical nature of any such factors. In this manner, a number constructed factors were used as new latent variables in the GSEM models characterising the direct and indirect effects between the independent variable/factors and the dependent variables/factors describing project success or risk management success in the UAE construction industry.

3.5.2 Structural Equation Modelling (SEM)

Recently, structural equation modelling (SEM) has been used extensively in a variety of research areas because it enables comprehensive and detailed analysis of a large number of variables and constructs that are insignificant correlations with each other and that form a complex network of significant interrelationships (Schumacker & Lomax, 2012; Stegmann, 2017). Typical survey data is particularly prone to mutual relationships among the measurable variables (survey items) because participants' answers are likely to be influenced by how they answered other questions. As a result, many survey items give rise to multiple numerical variables that are likely to be significantly correlated with each other. The analysis of such data using simple regressions or even multiple regressions may be challenging.

Consider a hypothetical example of three variables: *x*, *y* and *z*. If a simple regression is used or if simple Pearson or Spearman correlations are calculated to characterise the relationships between *y* and *x*, we may find, for example, that they depend on each other or significantly correlate with each other. However, this is not certain and could actually be incorrect because there could be a confounder *z* on which both *y* and *x* depend. If so the identified relationship between *y* and *x* may only be an illusion created by the fact that both *y* and *x* depend on *z*. In other words, if it were not for *z*, there would have been no relationship between *y* and *x*.

To avoid such errors, SEM must be used to consider all three variables simultaneously and establish any significant effects and effect paths between them. Figure 3.1 shows an example of such an SEM structure. In fact, *y* and *x* do not depend on each other (that is, they have no significant direct effect between them), but they both depend on the confounding variable *z*. K_{zx} and K_{zy} are the regression coefficients for the SEM's two significant regressions.

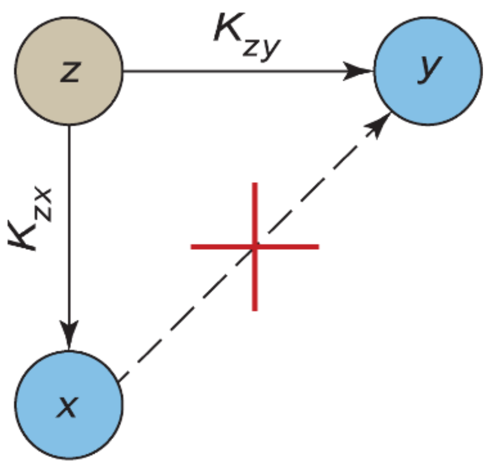


Figure 3.1: Confounding Variable

An alternative approach to considering multiple variables simultaneously is to use multivariate regressions (with multiple dependent variables) and multiple regressions (with multiple independent variables) (Hair *et al.*, 2014; Stevens, 2012; Tabachnick & Fidell, 2007). However, multiple regressions typically cannot simultaneously involve nearly collinear independent variables (variables that significantly correlate with each other). If two such variables are included in a multiple regression, then one often appears to be insignificant. However, this is incorrect, as the removal of the other variable from the model will make the first one significant. This happens because the significance of the first variable is 'suppressed' by the second due to their collinearity. This problem can typically be resolved by using SEM (Hair *et al.*, 2014; Stevens, 2012; Tabachnick & Fidell, 2007).

Thus, SEM allows for the consideration and characterisation of numerous variables (items) and constructs, some of which may be in causal relationships with each other, giving rise to a complex network of effect paths from the independent variables to the dependent variables (possibly with mediation by the other variables, giving rise to indirect effects). The particular success of SEM comes from its ability to consider and characterise the indirect effects of one variable on another through the mediation of a third.

3.5.3 Generalised Structural Equation Modelling (GSEM)

The developed survey instrument involved the categorical socioeconomic variables of the participants (Q1–Q16) and several categorical variables characterising the construction companies employing the study participants. In addition to this, item Q28 could be regarded as a categorical dependent variable characterising the success or failure of risk management and planning in those companies. Such a categorical dependent variable should be analysed with logistic or multinomial logistic regressions.

Unfortunately, the standard SEM cannot consider categorical variables (particularly those with three or more categories) or involve logistic or multinomial logistic regressions (StataCorp, 2015). It is noted that the GSEM model is an extension of SEM that GSEM can do the other aspects that SEM cannot do. Moreover, GSEM is available in the Stata14 software package (StataCorp, 2015).

3.5.3.1 Indirect Effects: Numerical Variables

Both SEM and GSEM allow for the identification of effect paths, including variables' direct and indirect effects on each other. The GSEM, however, can also involve and characterise direct and indirect effects of categorical independent variables on numerical and categorical dependent variables (StataCorp, 2015).

For example, let the direct effect of a numerical variable x on a numerical variable y be defined by a linear function as follows:

$$y = K_{xy}x, \tag{3.3}$$

where K_{xy} is the regression coefficient (Bollen, 1987; Stegmann, 2017). (For simplicity, assume that the intercept of this dependence is zero.)

An indirect effect is an effect that does not occur directly on variable y but rather through a mediating variable. This occurs, for example, if there are two numerical variables, x and z, and z has a direct effect on x, while x has a direct effect on y. These two direct effects can be represented by the two linear equations (relationships):

$$y = K_{xy}x \text{ and } x = K_{zx}z, \tag{3.4}$$

where K_{xy} and K_{zx} are the regression coefficients. It follows from these two equations that the effect of z on y can be described by:

$$y = K_{xy}(K_{zx}z) = K_{xy}K_{zx}z = K_{zy}z, \tag{3.5}$$

where

$$K_{zy} = K_{xy}K_{zx}. \tag{3.6}$$

K_{zy} is the regression coefficient for the indirect effect of z on y through the mediating variable x. Importantly, Equations 3.5 and 3.6 offer a simple way to calculate the regression coefficient for an indirect effect: it is simply the product of the regression coefficients of the direct effects in the path of the indirect effect.

This formula can easily be extended to any number of mediating numerical variables in the chain (path) of the indirect effect. The regression coefficient for the indirect effect will be the product all regression coefficients for the direct effects involved in the chain of the indirect effect.

This explanation of the direct and indirect effects for numerical variables has been significantly simplified for the sake of a conceptual understanding sufficient for this study. More detailed and consistent descriptions and analyses of the direct and indirect effects in SEM can be found in, for example, Bagozzi and Yi (2012), Bollen (1987), Stegmann (2017), Tenenhaus (2008) and Wolf *et al.* (2013).

The total effect of any independent (exogenous) variable or construct on the dependent (endogenous) variable or construct is the sum of all direct and indirect effects. Thus, the total effect is a measure of the overall impacts of the independent variables or constructs on the respective dependent variable or construct.

3.5.3.2 Indirect Effects: Categorical Variables

Unlike SEM, GSEM allows for the involvement and analysis of categorical variables. The indirect effects of categorical variables must be considered somewhat differently than those of the numerical variables as discussed in Section 3.5.3.1.

Suppose there is an indirect effect of the categorical variable x_2 on the numerical variable y through the mediating numerical variable x_1 (Figure 3.2). The effect of x_2 on x_1 is determined for categories 1 and 2 of x_2 relative to its base category. That is, the regression coefficients $(K_{21})_1$ and $(K_{21})_2$ are the variations of x_1 when x_2 is changed from the 0 (base) category to category 1 and to category 2 respectively (Bollen, 1987; Stegmann, 2017; Wolf *et al.*, 2013).

This statement can be represented mathematically as:

$$x_1 \rightarrow x_1 + (K_{21})_i, \tag{3.7}$$

where the index i = 0, 1, 2 indicates different categories of the x_2 categorical variable; $(K_{21})_0 = 0$; and $(K_{21})_1$ and $(K_{21})_2$ are the respective regression coefficients. $(K_{21})_1$ is generally different from $(K_{21})_2$ because they equal the variations of x_1 when changing from the base category $(x_2)_0$ to $(x_2)_1$ and $(x_2)_2$ respectively (Figure 3.2).

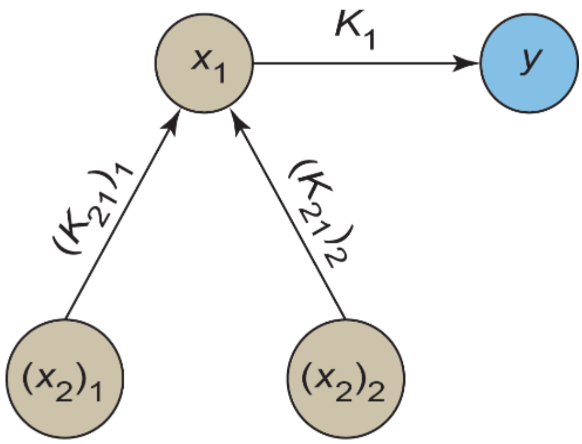


Figure 3.2. Indirect Effect: Categorical Variables

Figure 3.2 presents a GSEM structure with an indirect effect of the categorical variable x_2 (with categories 0, 1 and 2) on the numerical variable y through the mediation of the numerical variable x_1.

The effect of x_1 on y is given by:

$$y = K_1x_1 + C_1, \tag{3.8}$$

Which is similar to Equation 3.3 with the exception of the fact that a nonzero intercept C_1 has been included for greater generality.

The indirect effect of x_2 on y can then be obtained by substituting Equation 3.7 into Equation 3.8:

$$y = K_1[x_1 + (K_{21})_i] + C_1 = K_1x_1 + K_1(K_{21})_i + C_1 = K_1x_1 + [K_1(K_{21})_i + C_1]. \quad (3.9)$$

It can be seen that the indirect effect of x_2 on y through x_1 changes the intercept of the linear regression (Equation 3.8) by $K_1(K_{21})_i$, which could therefore be considered the size of the indirect effect. Note that in this case, the indirect effect is calculated in the same way as the indirect effect of a numerical variable as the product of the corresponding regression coefficients.

However, the meanings of the indirect effects are significantly different for the numerical and categorical variables: while the indirect effect of a numerical variable is characterised by a linear regression (Equation 3.5) with the regression coefficient $K_{zy} = K_{xy}K_{zx}$ (Equation 3.6), the indirect effect of a categorical variable is characterised by a linear regression (Equation 3.9) with the intercept altered by $\Delta C = K_1(K_{21})_i$, where ΔC is the variation of the intercept (strength of the effect) due to switching from the base category of the respective categorical variable to the considered category.

3.5.3.3 P-values for Indirect Effects

A *p*-value is a probability that the corresponding regression coefficient equals zero. The probability for the coefficient to be non-zero is therefore $1 - p$ (Greenland *et al.*, 2016; Knight, 2014). The probabilities for the coefficients to be non-zero for each link in the chain representing an indirect effect were determined. Multiplying them one by another gives the probability for the regression coefficient for the indirect effect to be non-zero. Subtracting this probability from 1 gives the *p*-value for the indirect effect.

This procedure is relevant to the indirect effects of numerical and categorical variables because, depending on whether the variable is numerical or categorical, the *p*-value is defined as the probability that the corresponding regression coefficient equals zero (Greenland *et al.*, 2016).

3.5.3.4 Model Fit in GSEM

Because there is no option in Stata14 to test fit for a GSEM model, the standard SEM approach was used but with suitably modified categorical variables. If they had only two categories each, they could formally be considered numerical variables with just two values corresponding to the two categories. In this case, Stata14 gives identical modelling outcomes when using SEM (with such formally numerical variables) and GSEM (with the true categorical variables). SEM was therefore used to evaluate the fit of GSEM models involving categorical variables with two categories, treating such categorical variables as numerical.

This approach does not work if the categorical variables have three or more categories. In that case, it was necessary to evaluate a GSEM model by collapsing some of the categories to those that appeared to be least different into one category so that all categorical variables had only two categories. After this collapsing procedure, standard SEM was used to evaluate model fit, formally considering the resulting categorical variables as numerical.

Because GSEM for the second model (Figure 5.14 in Chapter 5) contains multinomial logistic regression, Stata14 was unable to calculate fit for the whole GSEM model. In this situation, the procedure described earlier in this section was used. The model fit based on GOF indices could only be evaluated separately for the part of Model 2 involving the risk management practices construct as the dependent variable (Figure 5.14 in Chapter 5). The model fit for the second part of Model 2, involving the multinomial logistic regression in relation to Q28, was evaluated using the standard model-fit methods relevant to multinomial logistic regressions.

As discussed above, this section describes the data collection techniques and the survey measurement instrument as the main source of data for the quantitative analyses. Furthermore, it outlines the participants of the study, the data sample estimates, the dependent and independent variables and the statistical models employed in this thesis. The next section describes the qualitative investigative approaches in greater detail; in particular, how interviews data were collected and analysed.

3.6 Qualitative Approach

There are many widely held beliefs and meanings of the qualitative research method. All of those in use today were developed for the study of social, historical, political and risk phenomena, amongst others (Leppink, 2017). According to Molina-Azorin (2016), qualitative research is concerned with meanings, concepts, metaphors, symbols and *descriptions* of things, while quantitative research is concerned with *measures* of things. It thus allows researchers to investigate the processes by which people create and maintain a social reality.

More particularly, the qualitative research methodology often uses techniques such as focus group analysis, observation methods, ethnography, in-depth interviews, case studies and open-ended questionnaires to collect and analyse data (Pasian, 2015). The quantitative data itself is based the analysis of number measurements or frequency of a variable that is of interest; for example, correlating a contractor's qualifications to the quality of the project. The qualitative data is, on the other hand, based on the subjects' explanations of the phenomenon of interest; for example, how the subjects act or feel when working on a project with an underqualified contractor. In this way, the qualitative data can provide further insights; particularly into in-depth meanings and the complexities of human behaviour of an organisation structure, for example (Oltmann, 2016; Strang, 2015).

There are three types of research interview method: structured, semi-structured and unstructured (Denscombe, 2014). Semi-structured interviews were considered the most appropriate for this study. The interview method used in this study is discussed in Section 3.3.2.

The literature reviewed in Chapter 2 suggests that the qualitative research using the interview method can provide a deeper understanding of the cultural, financial, economic, societal structural, historical and political aspects including the most important aspect of risk phenomena. This data will help in triangulating much of the quantitative research analyses that have been done in this thesis in addition to providing much more valuable insights into the nature of risk management of construction projects in relation to the success of projects. It is therefore deemed that the semi-structured interview is an effective method for the gathering of valuable and authentic data to gain insights regarding the major research questions posed in this thesis.

It is best practice for interviews not to last more than 90 minutes, with 60 minutes being ideal so that neither the interviewer nor interviewee lose concentration (Mills & Birks, 2014). All the interviews conducted in this study were completed in less than 60 minutes. (see Appendix 6 for example of the interview questions). Other interview conditions such as ethical standards will be explored later in the thesis.

3.6.1 Conducting the Interviews

All interviewees were selected on the basis of self-selection sampling according to the sample selection criteria described earlier. The interviews were conducted face to face, since this method was the one most widely used and generally considered best by a number of authors (Creswell & Plano Clark, 2011; Fontana & Frey, 1994; Irvine *et al.,* 2013; Knox & Burkard, 2009; Oltmann, 2016; Ryan *et al.,* 2009; Sturges & Hanrahan, 2004; Yin, 2013). The face-to-face interviews allowed both the interviewer and the interviewee to use visual aids, to detect social cues and body language and to establish mutual trust so as to conduct the interview as a meaningful discussion instead of an interrogation.

Another option was the phone interview. However, this method has many critics. Vogl (2013, p. 581) noted that *"telephone interviews are often dismissed."* In Seidman's (2013) view, the telephone should only be used to set up the interview, not to conduct it. Doody and Noonan (2013), Jamshed (2014) and Merriam and Tisdell (2015) all set forth protocols for interviewing that assume it will be face to face.

Before beginning the interviews, ethics approval was obtained. Each interviewee first signed a letter of consent, shown in Appendix 3, and was asked after completing the survey if he or she was willing to participate in subsequent interviews. (This was survey item Q41; see Appendix 4.)

In this manner, 28 participants agreed to be interviewed and plans for the subsequent interviews were conducted by email. Of the 28, 13 were selected and semi-structured interviews were conducted mainly to further clarify and confirm types of project, construction risks, risk management and mitigation strategies, risk allocation practices, relationships with other parties and learning, decision-making and planning processes. The 13 interviewees were selected on the following basis:

- Availability matching the interviewer's travel arrangements to the UAE;
- Over 15 years of experience in the construction industry;
- Reasonable representation of the three participant categories (clients, contractors and consultants) in order to minimise bias; and
- No new information or themes are observed in the data (Boddy, 2016).

The interviews were tape-recorded, which, as Almalki (2016) noted, minimises interviewer error. If the interviewer does not need to take notes, he or she can play closer attention to what the interviewee says, make sure the interviewee has actually answered the question, and contingently ask more probing follow-up questions. Even so, some important points were written down by the interviewer as the interviewee spoke.

All interviewees were at least asked a set of 19 prepared questions (as shown in Appendix 6). In addition to this, they were at times asked other questions that were prompted by their previous answers – a type of clinical interview suggest by Ginsburg (2009). Thus, the interviews had the informal feel of a conversation.

Since all the selected participants spoke English, the interviews were conducted in English. The interview was transcribed and the transcripts were between three and 18 pages in length.

3.6.2 Analysing the Interviews

The recorded interviews were transcribed and coded (see Appendix 8). Because the interview data is inherently subjective, analysing and interpreting it calls for carefulness and judgement, whether the analysis is quantitative or qualitative (Kaefer *et al.,* 2015; Berelson, 1952; Krueger, 1997; Neuendorf, 2016; Rabiee, 2004). How much analysis is needed depends on the design and objectives of the research and on how simply conclusions can be drawn (Krueger, 1997; Neuendorf, 2016; Rabiee, 2004).

The literature offers multiple definitions of content analysis. According to the classical definition, it is a research method for the systematic, objective and qualitative analysis of the content of communication (Berelson, 1952). Patton (2005) defines it as a technique for making inferences by systematically and objectively identifying specified characteristics of messages, while for Bengtsson (2016) and Prasad (2008), it is any method of assessing the relative extent to which a particular message contains particular attitudes, references or themes.

Over several decades, content analysis has become increasingly widely applied and is used now in journalism, communication, psychology, management, sociology, business and many other fields (Akmam Syed Zakaria *et al*., 2018; Elo & Kyngas, 2008). It is of great use for detecting certain words, concepts, themes and phrases in an interview transcript, allowing the researcher to objectively quantify their presence (Bengtsson, 2016). Perhaps its greatest usefulness is in systematically and relatively easily sifting through large volumes of data for which other techniques of drawing inferences would be too expensive, or just impossible (Elo *et al.,* 2014; Hsieh & Shannon, 2005; Stemler, 2001). It is valuable when the research topic is focus of an individual, group or organisation.

In addition to written material, images, sounds, tables and symbols can also be subjected to content analysis. It can, for example, identify body language and facial gestures in communications in order to investigate and psychologically evaluate a person's state of mind. However, such applications were not germane to this study, which is more concerned with the participants' specific codes, risk factors and management strategies than with their attitudes and manner of speech.

There are many computer coding methods now in use for the analysis of interview data and Nvivo 11 software package is one of the most used in modern research.

3.6.3 NVivo 11

Although structuring and analysing transcripts (texts) can be extremely time-consuming, innovative software can make data coding less of a burden on the researcher (Al Yahmady & Alabri, 2013). Therefore, software packages are often used in order to conduct the data analysis more thoroughly and methodically. NVivo 11 was chosen as the qualitative data analysis (QDA) software for coding and analysing data in this study. This process allowed the researcher to spend less time on manual tasks and more on identifying themes, conducting in-depth analysis and drawing conclusions (Al Yahmady & Alabri, 2013; Wong, 2008; Zamawe, 2015). The coding schemes created for the interviews are discussed in more detail in Chapter 6.

Bazeley and Jackson (2013) note that NVivo 11 can aid data management (organising multiple data documents), the management of ideas, data querying (using software to answer queries), visual modelling (producing graphs to show the relationships between theoretical and conceptual data) and the reporting of data and results. In this study, the NVivo 11 was used to analyse the non-structured data and code it. Codes were chosen for their relevance to risks in the UAE construction industry and their commonality among at least four interviewees.

The word-tree approach was used to illustrate the identified relationships and frequencies with which different matters or words were used by different interviewees. Code frequencies were considered significant criteria for determining common risks and risk-related matters. (The tree map, nodes and codes are detailed in Appendix 8). Qualitative conclusions were made on the basis of code frequencies and expressed perceptions of the relevance of various matters to risks and risk management in the UAE construction industry. Comparisons were drawn between qualitative conclusions and those reached by previous researchers to ensure cross-validation and mutual validity or else to detect differences. A particular effort was made to reliably identify as many important risks and risk management approaches in the UAE construction industry as possible. Practical recommendations based on the quantitative and qualitative outcomes were derived and formulated and limitations of the study were identified and explained.

The results are discussed and the nature of analysis further illustrated in Chapters 4 (Summary and Descriptive Statistics), 5 (Questionnaire) and 6 (Interview Analysis).

3.7 Reliability and Validity

Reliability and validity are important aspects of all major research projects under which the findings and conclusions of the same may be judged. Research data are considered *reliable* if others using the same data collection method at different times but under similar conditions would get the same results (Ghosh & Jintanapakanont, 2004; McNeil, 1990). Reliability can be tested using techniques such as the internal consistency method (Cronbach's coefficient alpha), the split-half method, the parallel-form method and test-retest (Chisnall, 1993). In this study, Cronbach's coefficient alpha test was used as well as other strategies, such as checking the coding procedure and transcripts for errors to address the reliability of data gathered from the survey instrument and interview method.

Data are considered *valid* if they truthfully represent what is being studied (Leung, 2015; McNeil, 1990). *Qualitative validity* is achieved if the researcher has used various techniques to check the accuracy of the findings. *Quantitative validity* is achieved if the researcher can draw useful and meaningful inferences from scores produced by a given instrument (Creswell, 2013).

Creswell offers a number of strategies for checking qualitative validity, including (a) triangulating between participants' perspectives and (b) arranging a follow-up interview to present the concluding description and to conduct a final check of the original interview's results. To address the validity of the data aspect this study used follow-up interviews. The questionnaire itself was designed to assist in checking content validity. For example, the risk factors included in the questionnaire were based on a literature review and the results of the pilot test were used to improve the questionnaire. In addition to this, experts were used to judge the nature of the questions used in the instrument to justify that the responses would appropriately indicate the measure even when asked in a number of ways for example.

3.8 Ethical Considerations

Research ethics include the norms and standards of behaviour meant to protect the rights of anyone outside the research team who might be affected by the research, including, although not limited to, those who are its subjects (Bryman & Bell, 2015). Because any survey-based and/or interview-based research involves people who are not part of the research team, the interviewer's behaviour towards the participants is 'very' important.

In this study, there were a number of important aspects considered and it was especially important to adhere to the high ethical standards set for research of this type that involves the recording and analysis of subjects' responses either in the form of surveys or interviews for example. Firstly, it was made clear to the sample selected that their information would be kept confidential. Secondly, subjects were informed that they could withdraw at any time during the term of the study. Thirdly, the subjects would not be involved in any activity without their written consent and, finally, that there would be no deception of any type and that the subjects would be informed about every step of the research process.

An ethics application was officially made for this study (shown in Appendix 1) and it was duly approved by the Bond University Human Research Ethics Committee (BUHREC) before the actual selection of sample. This process was undertaken well before any survey or interview data collection began.

To ensure confidentiality, data was stored on a secure external server and physical copies were transferred onto CDs and stored in a locked location. The participants' names were changed in the final report and care was taken to ensure that no one is identifiable. This research was conducted entirely by a single postgraduate researcher under the close guidance of three academic supervisors.

3.9 Conclusion

This chapter discussed the aims, specific research questions and the design of the thesis. The mixed-methods methodology chosen to conduct the research was explained. The discussion included the rationale for choosing the research approach, the procedures for data collection and analysis, and the strategies for enhancing data reliability and validity. As noted, the study adopted a mixed-methods research design, using a questionnaire and interviews as the main data collection tools. Finally, relevant ethical considerations were also discussed.

In sum, the review of the literature showed that there had been relatively little research on stakeholders' practices and perceptions in the UAE construction industry in terms of the main variables of culture and economic aspects of success as described in this study. To address this significant knowledge gap, the study requires both wide and in-depth research to identify and characterise major trends and/or factors that could influence the success of construction projects. This goal is more likely to be achieved by using a mixed-methods design, which is more likely to capture and characterise a broader variety of such trends, some of which might not be immediately obvious or expected. Figure 3.3 summarises the research approach for this study. Chapter 4 will present a summary and the descriptive statistics of the data drawn from the large sample questionnaire.

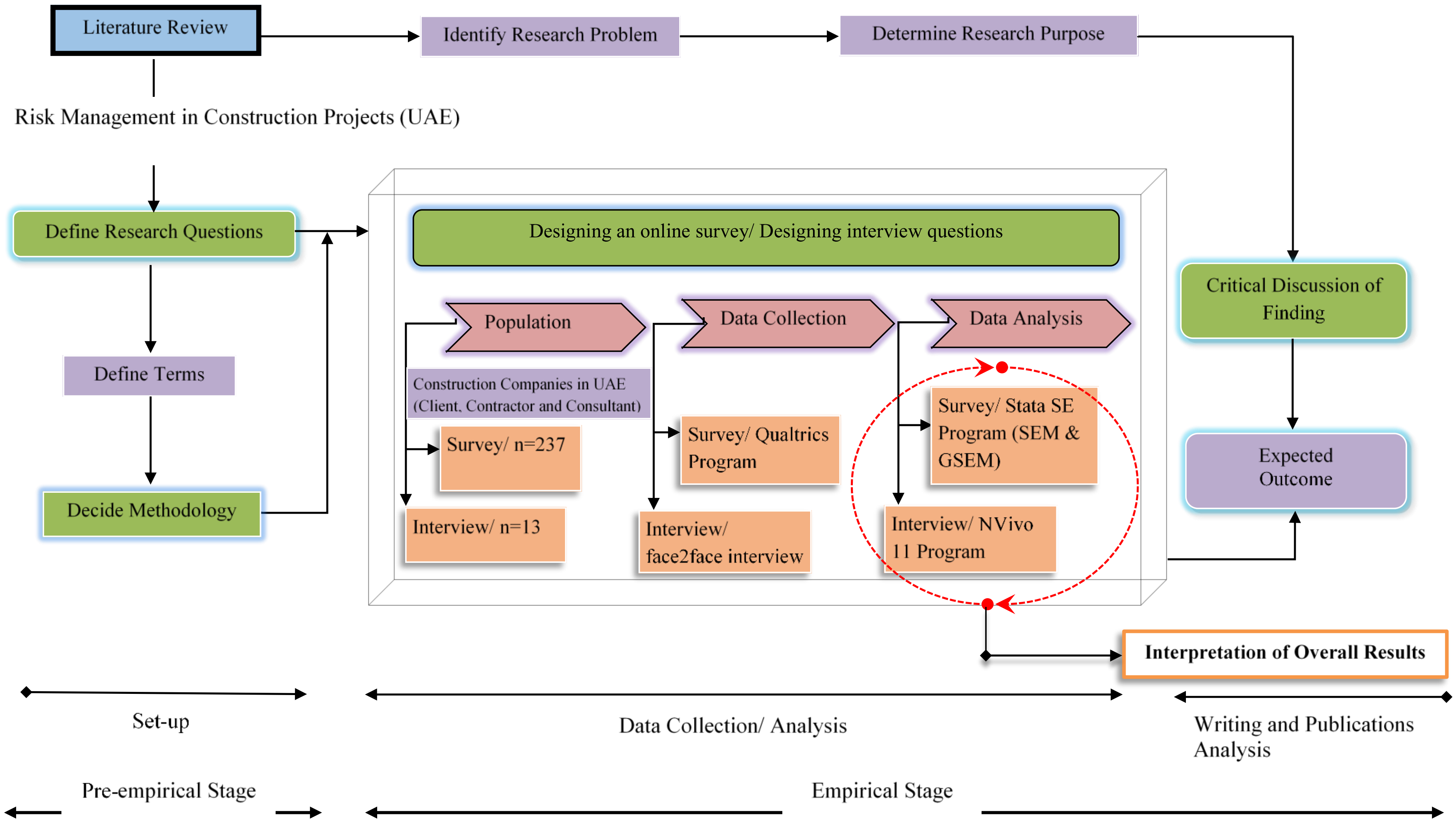


Figure 3.3: Summarised the Research Methods used

Source: Author (2018)

Chapter 4: Summary Statistics and Group Comparison

4.1 Introduction

Chapter 3 discussed the aims, research questions and the research methodology used in this study. The chapter also included the background to the research approach, the nature of the sample and the data collection. Further, Chapter 3 explained the level of the sample size used for the questionnaires and interviews, the data analysis methods used and the statistical and mathematical analyses methods that were adopted.

This chapter provides a descriptive analysis of the summary statistics analysis of the questionnaire data to understand the basic structure of the available sample and the composition of the participating cohort. This analysis was mainly to gain an understanding of potential relationships and trends between the variables, which will also be verified and confirmed by the GSEM and CFA modelling presented in Chapter 5.

4.2 Data Sample Composition

As stated in Chapter 3, the measurement instrument used in this study is an online survey (Appendix 4) targeting professionals involved in managing construction projects in the UAE. Figure 4.1 shows the distribution of the participant cohort over different categories of significant demographic variables, with respective frequencies (presented in parentheses).

As shown in Appendix 4, other demographic variables are measured using the survey instrument, including items Q5–Q7 and Q9–Q16. These variables are not considered in detail here because using the χ^2-test, these variables are not independent of the demographic variables. Therefore, they do not need to be considered in the statistical models developed and discussed in Chapter 5.

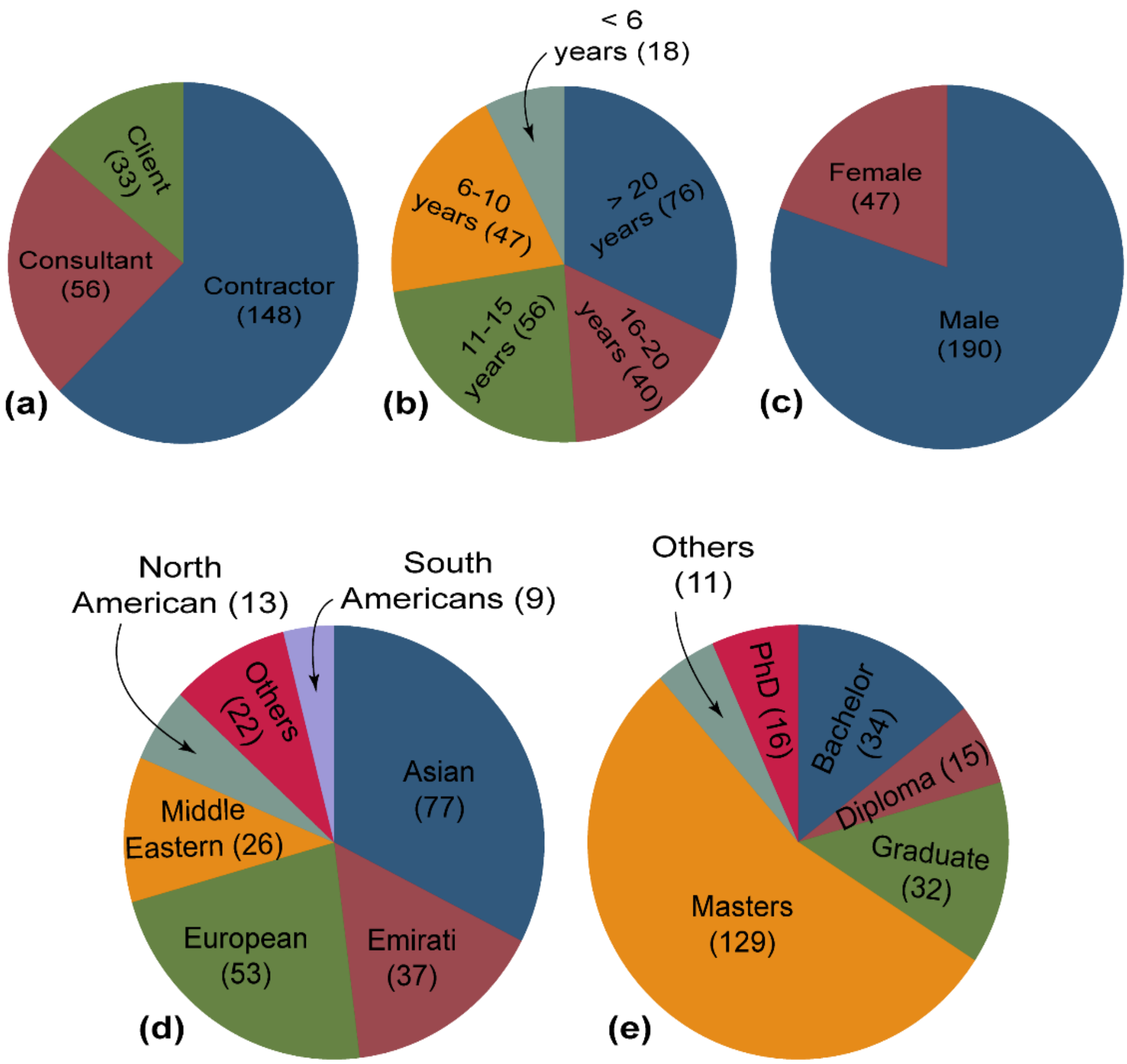


Figure 4.1: Demographic Characteristics

Figure 4.1 presents the following demographic characteristics of the sample of 237 participants: (a) job title (Q1; Appendix 4); (b) years in the role (Q2); (c) gender (Q3); (d) nationality (Q4) and (e) education level (Q8).

As shown, the sample of 237 participants was a reasonable representation of different cohorts of project management professionals in UAE construction companies. The smallest sub-cohorts were participants from South America (nine individuals) and participants with education levels other than those listed in Figure 4.1e (11 individuals). However, this was not considered a significant issue for this study because the consideration of such sub-cohorts in a statistical model dealing with a significantly larger overall cohort of participants is typically acceptable and reasonable (depending on the resultant model errors). In addition to this, the nationality variable (Q4 and Figure 4.1d) was not significant in any of the developed models

(Chapter 5) and all education levels in Q8, except for the PhD level, had to be joined into one base category to ensure the largest possible statistical significance of this variable (Table 5.8).

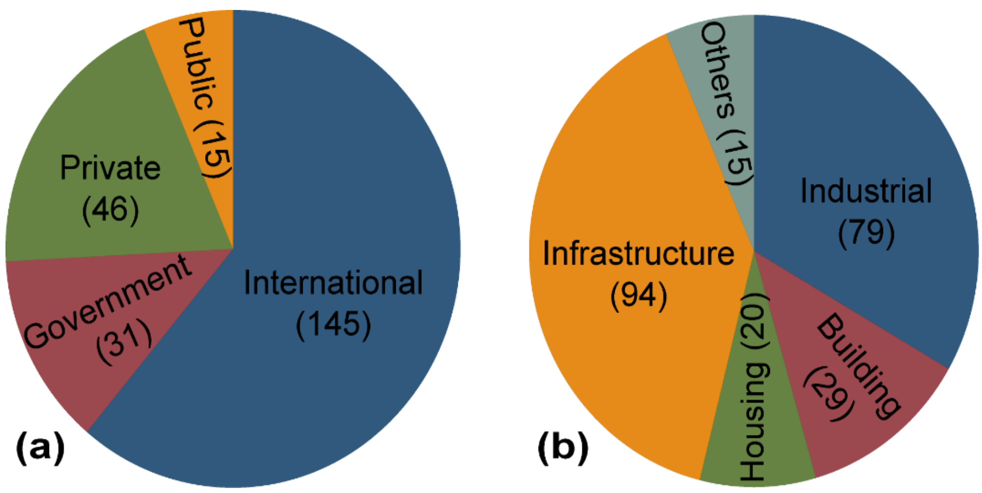


Figure 4.2: Company Characteristics

Figure 4.2 presents the company characteristics for the sample of participants for (a) company ownership (Q17; Appendix 4); and (b) company key activities (Q18).

Similarly, the data sample sufficiently and reasonably represented different company types (Figure 4.2), which was adequate for the development of the proposed statistical analysis and modelling. Similar to the education-level variable, the variables of company ownership (Q17 and Figure 4.2a), company activities (Q18 and Figure 4.2b) and years in role (Q2 and Figure 4.1b) were subsequently re-categorised to ensure better statistical significance in the developed models (Table 5.8).

Table 4.1 presents further information about the counts/frequencies and respective percentages for different categories of demographic and company variables Q1–Q18, including the counts already illustrated in Figures 4.1 and 4.2.

Table 4.1: Summary Measures for Demographic and Company Variables

Variable	Category	Count / frequency	Percentage (%)
Q1	Client	33	13.92
	Consultant	56	23.63
	Contractor	148	62.45
Q2	11-15 years	56	23.63
	16-20 years	40	16.88
	21 years or more	76	32.07
	5 years or less	18	7.59
	6-10 years	47	19.83
Q3	Female	47	19.83
	Male	190	80.17
Q4	Asian	77	32.49
	Emirati	37	15.61
	European	53	22.36
	Middle Eastern	26	10.97
	North American	13	5.49
	Other	22	9.28
	South American	9	3.80
Q5	11-15 years	23	9.70
	16-20 years	37	15.61
	21 years or more	102	43.04
	5 years or less	36	15.19
	6-10 years	39	16.46
Q6	11-15 years	18	7.59
	16-20 years	50	21.10
	21 years or more	90	37.97
	5 years or less	63	26.58
	6-10 years	16	6.75
Q7	Arabic	41	17.30
	English	155	65.40
	Indian	26	10.97
	Other	15	6.33
Q8	Bachelor's degree	34	14.35
	Diploma	15	6.33
	Graduate certificate/diploma	32	13.50
	Master's degree	129	54.43
	Other	11	4.64
	PhD	16	6.75
Q9	Asia	64	27.00
	Europe	65	27.43
	Middle East	50	21.10
	North America	12	5.06
	Other	19	8.02
	South America	4	1.69
	UAE	23	9.70
Q10	No	48	20.25
	Yes	189	79.75
Q11	11-15 years	43	18.14
	16-20 years	58	24.47
	21 years or more	70	29.54
	5 years or less	18	7.59
	6-10 years	48	20.25

Table 4.1: Summary Measures for Demographic and Company Variables Continued

Variable	Category	Count / frequency	Percentage (%)
Q12	Building	24	10.13
	Housing	21	8.86
	Industrial	95	40.08
	Infrastructure/Heavy Engineering	83	35.02
	Other	14	5.91
Q13	No	206	86.92
	Yes	31	13.08
Q14	11-15 years	45	18.99
	16-20 years	28	11.81
	21 years or more	37	15.61
	5 years or less	61	25.74
	6-10 years	66	27.85
Q15	11-15 years	44	18.57
	16-20 years	40	16.88
	21 years or more	27	11.39
	5 years or less	72	30.38
	6-10 years	54	22.78
Q16	No	66	27.85
	Yes	171	72.15
Q17	Government owned	31	13.08
	International	145	61.18
	Private	46	19.41
	Public	15	6.33
Q18	Building	29	12.24
	Housing	20	8.44
	Industrial	79	33.33
	Infrastructure/Heavy Engineering	94	39.66
	Other	15	6.33

Table 4.1 summarises the percentage measures and frequencies for the categorical demographic and company variables Q1–Q18 (Appendix 4) over the whole sample of 237 participants. The percentages for each item add up to 100% and the counts for each item add up to 237.

The sample involves reasonable numbers of participants in all categories. The smallest participant representations were in Q9 (four for South America) and Q4 (nine for South America). This might result in lower reliability of the outcomes for these categories in items Q9 and Q4. However, neither variable was significant in the modelling (as is indicated in Chapter 5); thus, the relatively low counts for the two categories in these two survey items were not significant for the obtained model outcomes.

4.3 Relationships Between Categorical Variables

The developed survey instrument contained numerous demographic (categorical) variables, including those characterising participants' employment, experience, duration of residency in the UAE and qualifications (see items Q1–Q16 in Appendix 4). Many of these demographic variables may not be independent of each other. In addition to this, demographic variable Q12, which reflected participants' relevant areas of experience, was likely to be in a significant relationship with company variable Q18, which reflected key areas of companies' activities. This is because professionals employed by a construction company are likely to have work experiences that are directly related to the areas of the companies' activities.

Therefore, it was important to establish reasonably independent demographic variables so that they could be included in the subsequent analysis and modelling. This was important for two reasons: (1) to simplify the statistical modelling and reduce the number of variables and (2) to avoid unnecessary relationships in the developed GSEM structures and focus on the essential effects on the success of construction projects.

Analysis of the relationships for all pairs of the categorical demographic and company variables Q1–Q18 was conducted using the χ^2-test of independence (McHugh, 2013; Molugaram & Rao, 2017; Ross, 2017). The outcomes of this test were in the form of *p*-values characterising statistical significance of the respective relationships for all pairs of the categorical variables (Table 4.2). For cases in which the calculated *p*-values were larger than the conventional significance threshold of 0.05, the corresponding relationships were not regarded as significant and their corresponding *p*-values are not shown in Table 4.2. All *p*-values below the threshold value of 0.05 indicated significant relationships between the variables and are shown in Table 4.2.

In particular, Q2, Q5, Q6, Q11, Q14 and Q15, which are related to years of experience and/or residency in the UAE (Appendix 4), are significantly related to each other (see the grey-shaded entries in Table 4.2). This important outcome demonstrates that there is no need to consider all categorical variables (Q2, Q5, Q6, Q11, Q14 and Q15) but it is sufficient to consider only one of them in any of the models developed in Chapter 5. Item Q2 ('How long have you been in this role?') was chosen to represent all six experiences and/or residency variables in the statistical modelling, although any of the six variables could have been considered instead. An additional reason favouring the choice of categorical variable Q2 was that work experience in an employment role within the participating company appeared as a more important characteristic compared with, for example, the number of years of residence in the UAE (Q5) and the number of years in project management (Q14).

Similarly, (and as expected), Q12 and Q18 have a significant relationship (with $p < 0.001$; Table 4.2). Thus, consideration of Q12 is not necessary if Q18 is properly considered. Therefore, the modelling did not involve Q12.

Table 4.2: χ^2-test Outcomes for Demographic and Company Variables

Survey items	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
Q1																	
Q2		<0.001															
Q3		0.014															
Q4																	
Q5		<0.001		<0.001													
Q6		<0.001		<0.001	<0.001												
Q7				<0.001	<0.001	<0.001											
Q8	0.045				0.030		0.003										
Q9				<0.001	<0.001	0.001	<0.001										
Q10		0.035			<0.001	0.024	0.035	0.004									
Q11		<0.001			0.002	0.001		0.012		0.014							
Q12		<0.001	0.001	0.004	<0.001	0.014	<0.001										
Q13				0.005				<0.001	0.002	0.011	0.005	<0.001					
Q14		0.002		0.010	0.010	0.012				0.001	<0.001	<0.001	<0.001				
Q15	0.007	<0.001			<0.001	0.001			0.005		<0.001	0.002	0.038	<0.001			
Q16				<0.001	0.001	0.004	<0.001		<0.001			0.045					
Q17				<0.001	<0.001	0.004	<0.001		<0.001			0.002				<0.001	
Q18		<0.001	0.004	0.028	<0.001	0.001	0.002	0.016		0.048		<0.001	0.001			0.020	<0.001

Note:

Outcomes (p-values) from the χ^2-test for all pairs of the categorical demographic and company variables Q1–Q18 (Appendix 4). Missing entries in the table indicate that the respective p-values are greater than the adopted significance threshold of 0.05, and there is no significant relationship between the corresponding variables. Grey shading indicates p-values for the variables Q2, Q5, Q6, Q11, Q14 and Q15, reflecting years of experience and/or residency (Appendix 4). Yellow shading indicates significant relationships for which graphs are presented below.

It is important to note that the conclusions derived based on the χ^2-test of independence are only indications of whether certain variables should not be involved in statistical modelling because of their significant mutual relationships. Given the descriptive nature of this test (not adjusted for any other variables), these indications are not certain and typically require further confirmation.

Therefore, repeated attempts were made to involve the significantly related demographic variables in the GSEM modelling (results are presented in Chapter 5), but they were not statistically significant. This further corroborated the conclusion that the demographic variables Q5, Q6, Q11, Q12, Q14 and Q15 should not be involved in the modelling.

The significant relationships highlighted in yellow in Table 4.2 are illustrated graphically and discussed further in this section. Figure 4.3 shows the histograms of percentages of response counts for different categories in items Q8 (Figure 4.3a) and Q15 (Figure 4.3b) for the three different categories of job roles (client, contractor and consultant) in Q1 (Appendix 4). The sums of all percentages for each of the three histograms in Figures 4.3a and 4.3b are equal to 100%. Most participants (> 50%) in all three job roles had a master's level of education, indicating high levels of education and qualification in UAE construction companies. Around 70% of clients had a master's degree (Figure 4.3a). The proportion of graduate certificates/diplomas and PhD degrees was the largest for contractors, whereas the proportion of bachelor degrees was around the same for all three job roles.

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.3: (a) Q8 ('What is the highest level of education you have completed to date?'), (b) Q15 ('How many years of experience have you been involved in the decision-making process about whether or not to proceed with construction projects?') versus the categorical variable Q1 ('Please indicate your job title') with the three categories of 'contractor' (base category), 'consultant' and 'client' (on the horizontal axes).

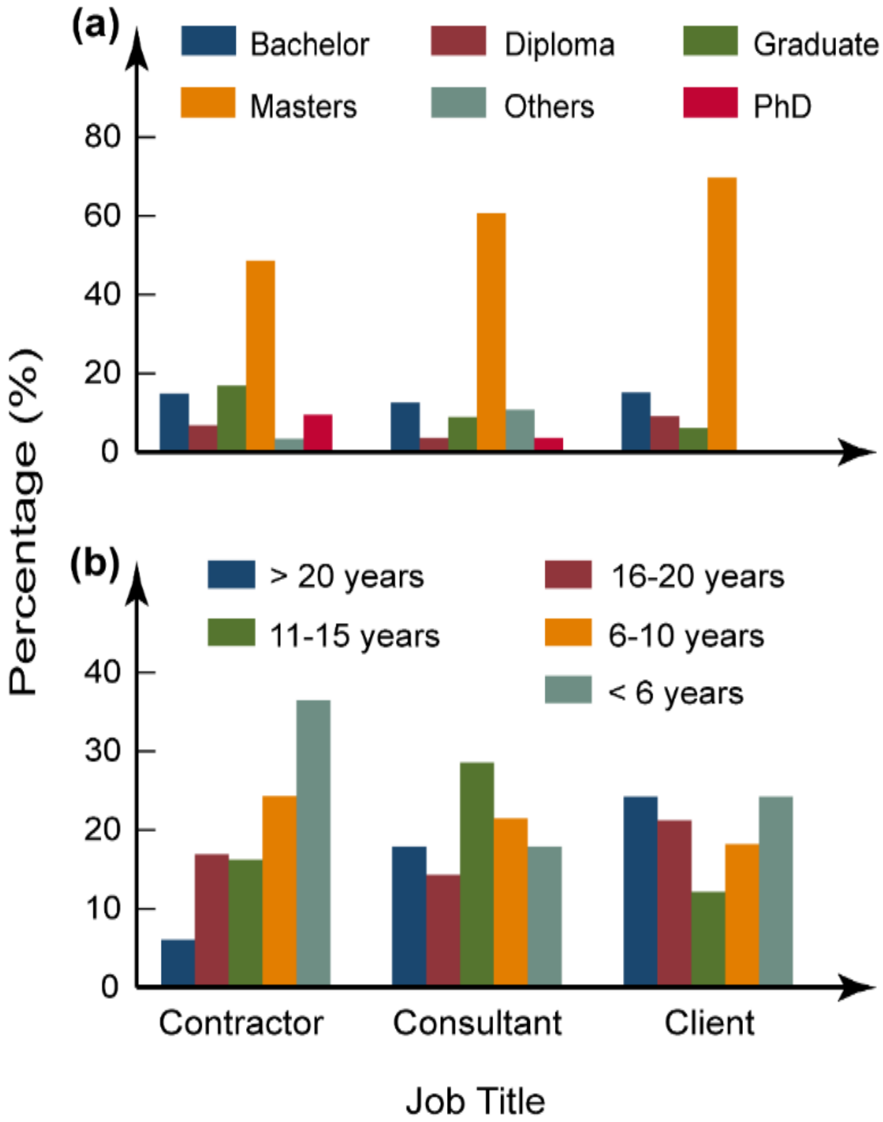


Figure 4.3: Relationships between Q8, Q15 and Q1

Interestingly, contractors had the highest proportion of employees with less than six years' experience in the role, whereas clients had the highest proportion of highly experienced staff with more than 20 years in the role (Figure 4.3b). This can be explained by the nature of client and contractor roles. A contractor is a company that directly undertakes construction. The associated challenge and direct involvement (including potential risks) are likely to be the greatest for contractors, which is probably the reason for the larger fluidity of the workforce, resulting in a large proportion of employees with less experience in their role.

In contrast, clients are not directly involved in construction, but they make construction orders and provide finances for construction. The more prestigious and financially advantageous nature of this role results in a significantly larger proportion of employees with more than 20 years' experience. However, it is not appropriate to suggest that employees with more experience mostly come from client organisations. As shown in Figure 4.1a, the proportion of client organisations in the overall sample is quite small compared with contractors. Therefore, despite the significantly larger proportion of highly experienced staff with greater than 20 years in client organisations (Figure 4.3b), it can be concluded that, in the whole sample, there were approximately equal (or similar) numbers of participants with greater than 20 years' experience in contractor, consultant and client organisations.

The same cannot be said about participants with less than six years' experience in the role. As shown in Figures 4.1a and 4.3b, most participants in the sample came from contractor organisations. This important observation demonstrates that the outcomes relevant to the least experienced participants may be biased towards contractor organisations unless the outcomes are properly adjusted for variable Q1. Such adjustments can only be achieved in a comprehensive statistical model involving and adjusting for all significant variables.

This is another illustration of the need for suitable statistical models for the analysis of the available data sample. The use of simple regressions between pairs of variables is inappropriate because they are likely to cause significant biases such as the example discussed in this paragraph.

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.4: (a) Q2 ('How long have you been in this role?'), (b) Q12 ('What does your experience in construction project types include?') and (c) Q18 ('What are the key activities of your organization?') versus the categorical variable Q3 ('gender') with the two categories 'male' and 'female' (on the horizontal axes).

As shown in Figure 4.4a, there is a trend towards greater work experience among male participants compared with female participants. For example, while the male sub-sample of participants was dominated by highly experienced employees with greater than 20 years of experience in the role, the female sub-sample was dominated by employees with 16 to 20 years' experience in the role (Figure 4.4a).

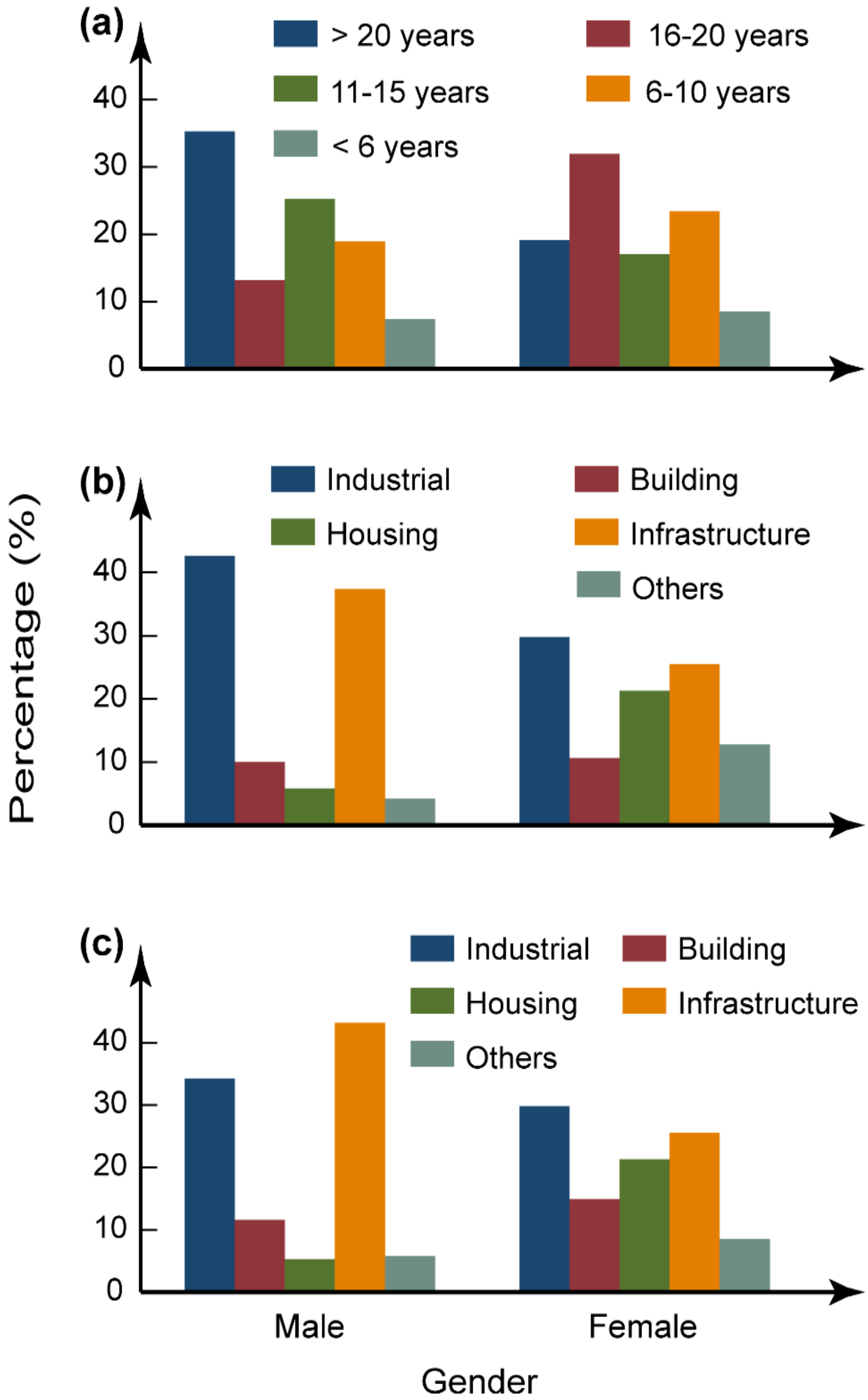


Figure 4.4: Relationships between Q2, Q12, Q18 and Q3

The male participants mostly had experience in industrial and infrastructure/heavy engineering construction projects (Figure 4.4b), whereas female employees had more evenly distributed experience (Figure 4.4b), particularly in industrial, infrastructure/heavy engineering and housing construction projects.

Similar distributions for male and female participants were obtained for Q18 ('What are the key activities of your organisation?') (Figure 4.4c). This was expected because the participants' experiences in types of construction projects should be closely related to the key activities of their organisation. The similarity between Figures 4.4b and 4.4c is another corroboration of the correctness of the previously explained decision not to consider Q12 because of its close relationship to Q18.

Participants with 16 to 20 years' experience in their role were more dominant among those who did not have any formal training in risk management practices (Figure 4.5a). Further, the other three experience categories (more than 20 years, 11 to 15 years and 6 to 10 years) were more dominant among those who did have formal training in risk management practices (Figure 4.5a). Formal training in risk management practices may have been more extensively provided or encouraged greater than 20 years ago and 6–15 years ago. This would explain the described trends in the data sample. The observation that the proportion of the least experienced participants (with less than six years in the role) is larger among those with no formal training in risk management (RM) practices (Figure 4.5a) indicates a possible trend towards abolishing this type of training. This trend could be regarded as undesirable but, as it was not significant in Models 1 and 2 (Chapter 5), there is no need to consider it further.

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.5: (a) Q2 ('How long have you been in this role?') and (b) Q8 ('What is the highest level of education you have completed to date?') versus the categorical variable Q10 ('Have you received any formal training in risk management practices?') with the two categories 'No' and 'Yes' (on the horizontal axes).

The proportion of participants with a master's level of education among those who had formal training in RM practices was notably larger than among those who did not have any such training (Figure 4.5b). Given that the overall number of participants with formal training in RM practices was around four times larger than those with no formal training (Table 4.1), it can be concluded that most participants with a master's level of education also had formal training in RM practices.

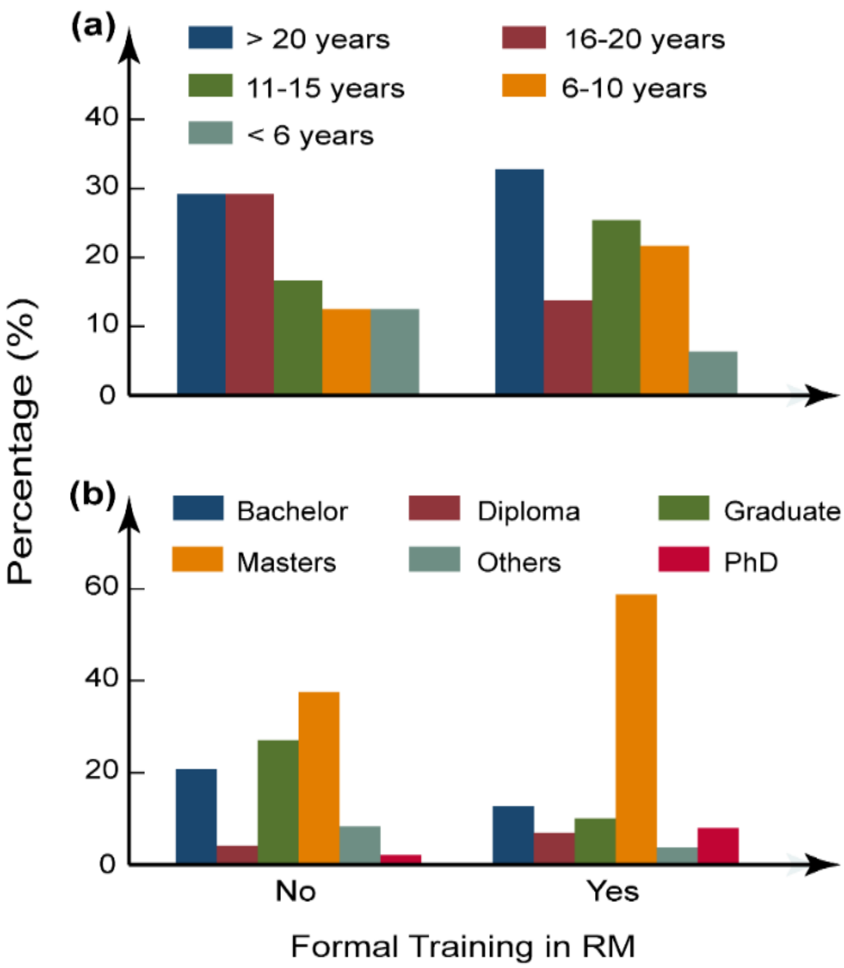


Figure 4.5: Relationships between Q2, Q8 and Q10

Item Q13 ('Do you have formal project management qualification?') could be perceived as somewhat close to item Q10 ('Have you received any formal training in risk management practices?'). However, formal training in RM practices might not be the same as formal project management qualifications, which should be regarded as a more general type of qualification (possibly including formal training in RM practices).

This significant difference is confirmed by the largely reversed frequencies of 'Yes' and 'No' answers to these two questions: 189 and 48 for Q10 and 31 and 206 for Q13 (Table 4.1). Therefore, consideration of the relationships associated with Q13 (Figure 4.6) is justified irrespective of the relationships associated with Q10 (Figure 4.5).

In particular, the comparison of Figures 4.5b and 4.6b reveals a degree of similarity between the related histograms but also demonstrates significant differences. In Figure 4.6b, most participants with a master's degree did not have any formal project management qualifications, which was particularly different from formal training in RM practices (Figure 4.5b). However, a large proportion of participants with a PhD degree had formal project management qualifications (Figure 4.6b).

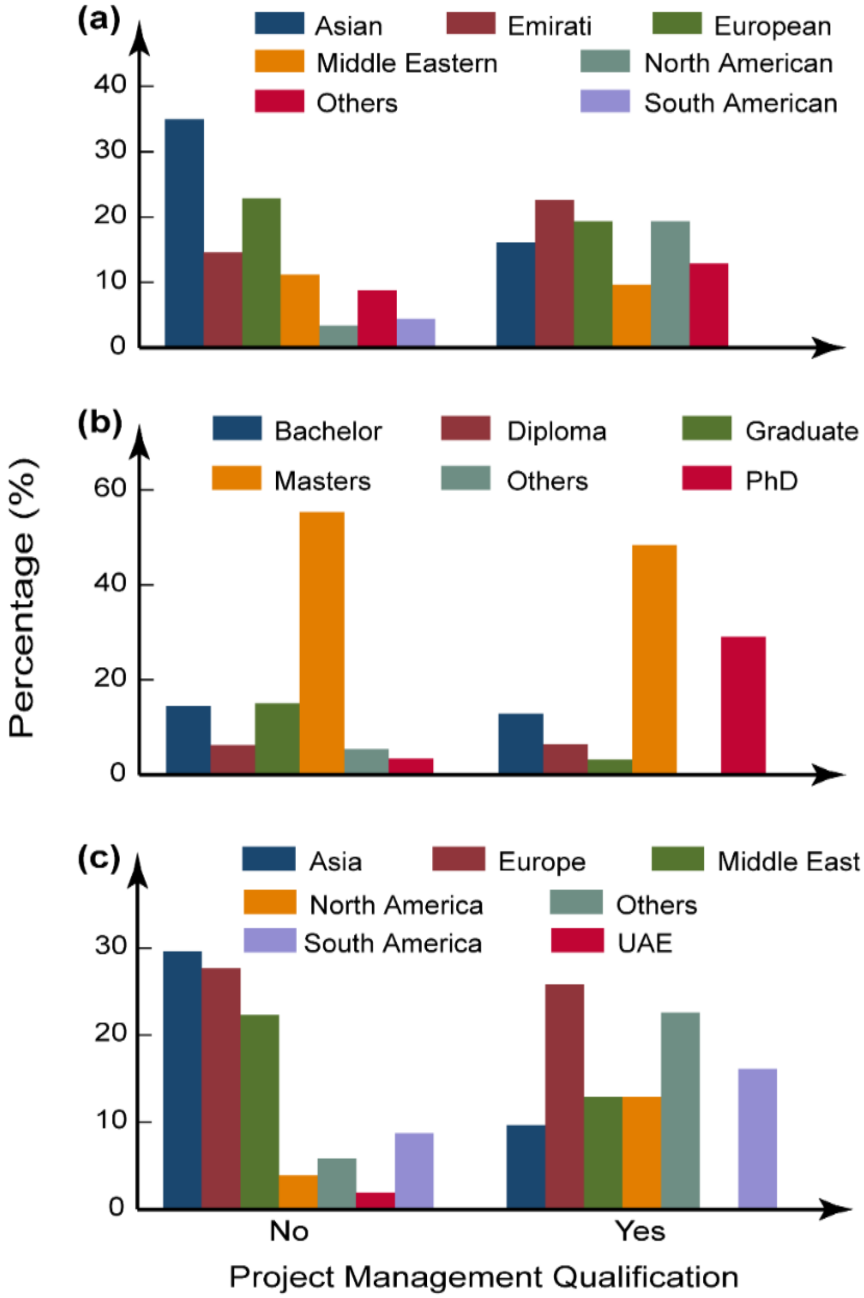


Figure 4.6: Relationships between Q4, Q8, Q9 and Q13

The histograms for the count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.6: (a) Q4 (‘What is your nationality?’), (b) Q8 (‘What is the highest level of education you have completed to date?’) and (c) Q9 (‘Where did you do most of your formal study?’) versus the categorical variable Q13 (‘Do you have formal project management qualification?’) with the two categories ‘No’ and ‘Yes’ (on the horizontal axes).

Among those who did not have formal project management qualifications, most were Asians, followed by Europeans and Emiratis (Figure 4.6a). Among those who had formal project management qualifications, most were Emiratis, closely followed by Europeans, North Americans and Asians (Figure 4.6b). A somewhat similar picture can be seen for item Q9 (‘Where did you do most of your formal study?’) (Figure 4.6c). Once again, Asians were ranked first among those who did not have any formal project management qualifications and Emiratis were ranked first among those who had formal project management qualifications.

However, the histogram of the ‘Yes’ response in Figure 4.6c should be treated with caution—particularly when comparisons between the ‘Yes’ and ‘No’ responses are attempted. This is because the frequency of the ‘Yes’ response to the question about formal project management qualifications was almost seven times lower than for the ‘No’ response (Table 4.1). This issue once again highlights the need for the development of comprehensive statistical models enabling a proper analysis of the available data, including items with significantly different frequencies.

Figure 4.7 shows three more sets of histograms associated with Q13. Figure 4.7a illustrates the relationships between items Q10 and Q13. It shows that a lack of formal project management qualifications is expected to be positively associated with a lack of formal training in RM practices. Figure 4.7b shows that different categories of experience in the construction industry (Q11) (excluding the less than 6 years’ category) have approximately the same representation among participants with no formal project management qualifications.

Further, among participants who possessed formal project management qualifications, the proportion of highly experienced individuals (with greater than 20 years of experience) significantly dominated all other experience categories (the second histogram in Figure 4.7b). This could be because formal project management qualifications might have been favoured more strongly more than 20 years ago or because more experienced participants had more opportunities over the duration of their experience to obtain such qualifications.

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.7: (a) Q10 (‘Have you received any formal training in risk management practices?’), (b) Q11 (‘How many years of experience do you have in the construction industry?’) and (c) Q12 (‘What does your experience in construction project types include?’) versus the categorical variable Q13 (‘Do you have formal project management qualification?’) with the two categories ‘No’ and ‘Yes’ (on the horizontal axes).

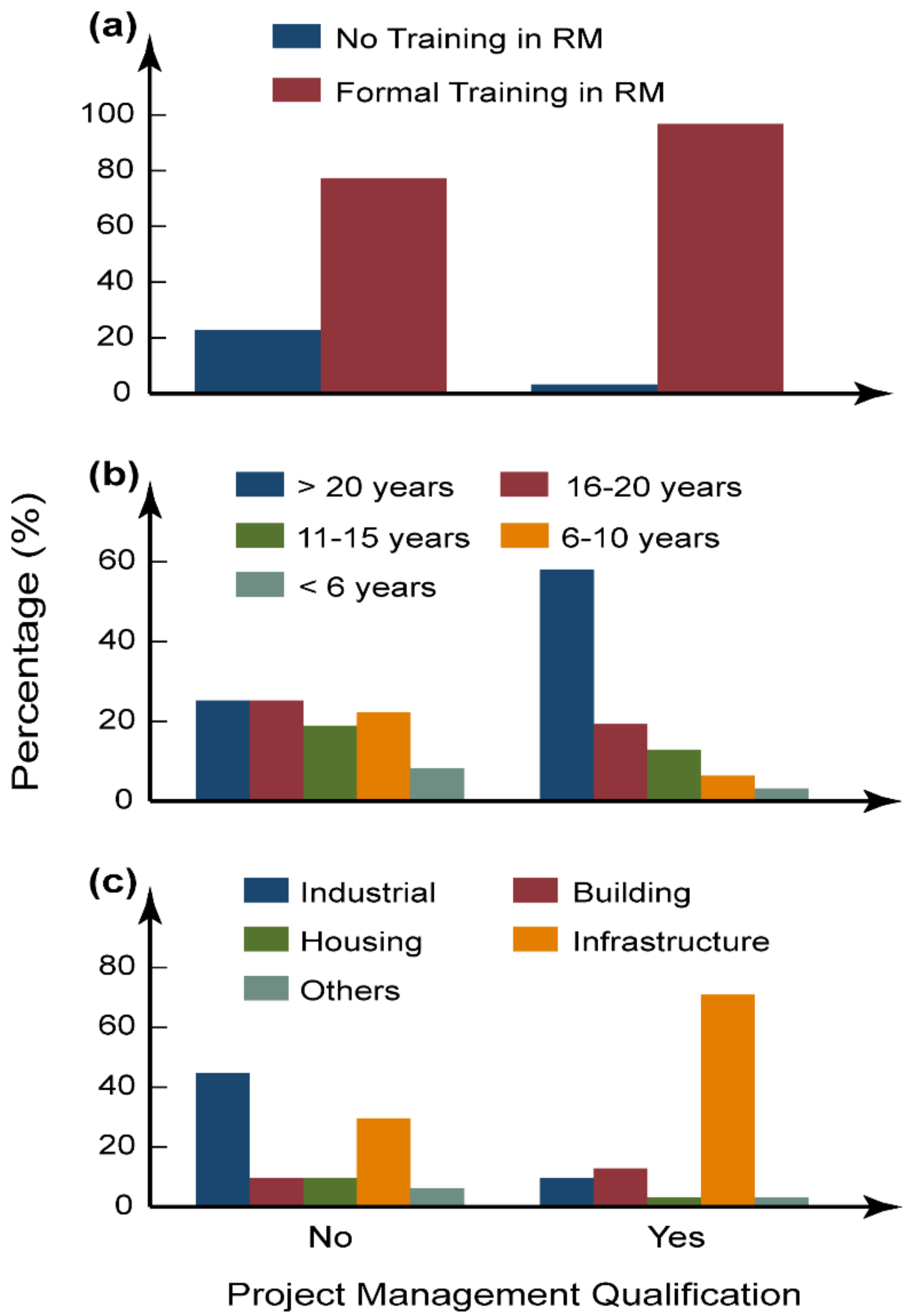


Figure 4.7: Relationships between Q10, Q11, Q12 and Q13

Most participants (around 70%) with formal project management qualifications had experience in infrastructure/heavy construction projects (the second histogram in Figure 4.7c). Most participants (around 70%) with no formal project management qualifications had experience in either industrial or infrastructure/heavy construction projects (the first histogram in Figure 4.7c).

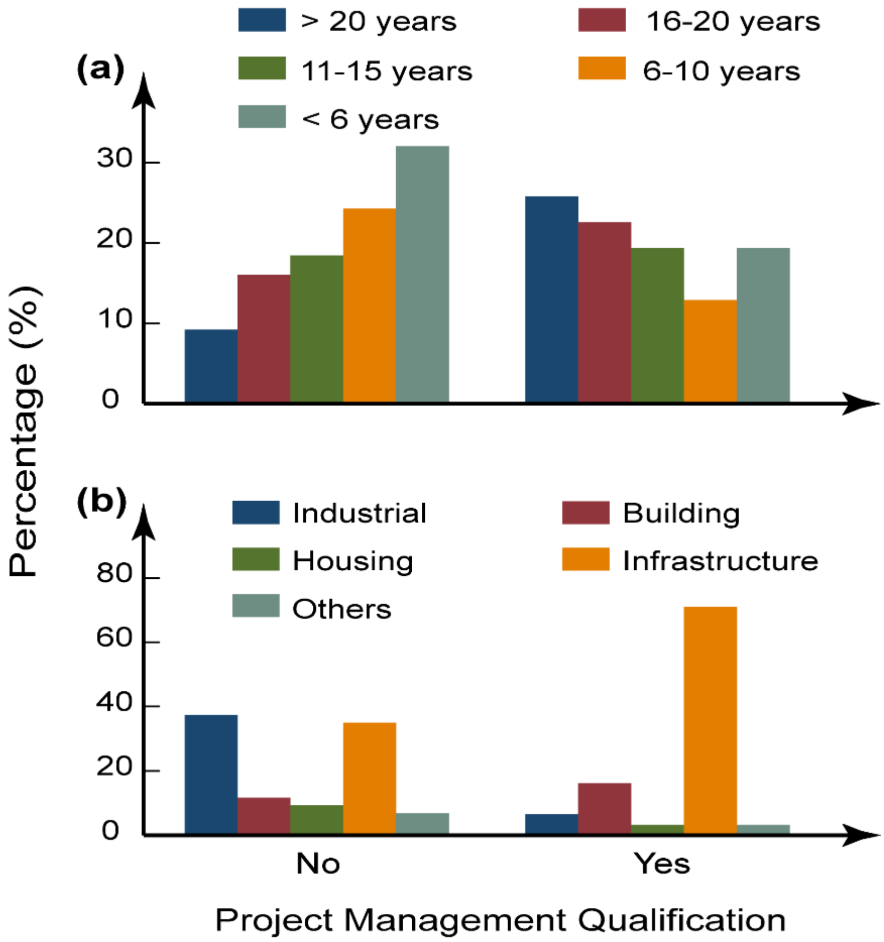


Figure 4.8: Relationships between Q15, Q18 and Q13

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.8: (a) Q15 ('How many years of experience have you been involved in the decision-making process about whether or not to proceed with construction projects?') and (b) Q18 ('What the key activities of your organisation?') versus the categorical variable Q13 ('Do you have formal project management qualification?') with the two categories 'No' and 'Yes' (on the horizontal axes).

Interestingly, among participants who did not have formal project management qualifications, participant numbers decreased almost linearly with the increasing number of years of experience in the decision-making process about whether to proceed with construction projects (the first histogram in Figure 4.8a). The opposite trend is observed for those who had formal project management qualifications (see the second histogram in Figure 4.8a). These trends (particularly the second histogram in Figure 4.8a) can again be explained by the proposition that, with increasing duration of experience, participants are likely to have more opportunities (over time) to gain formal project management qualifications. The striking similarities between

Figures 4.7c and 4.8b once again demonstrate that there is no need to consider both Q12 and Q18, and only Q18 can be selected for inclusion in any modelling of the available data sample.

Figure 4.9 illustrates the significant relationships between items Q17 ('Company ownership') and Q18 ('What the key activities of your organization?') versus Q16 ('Have you ever worked in a construction project in a country other than the UAE?'). Among participants who had experience in construction projects outside the UAE, most (around 70%) worked for international companies (Figure 4.9a). Among those who had no experience outside the UAE, participant distribution among companies with different ownerships was smoother and more even (the first histogram in Figure 4.9a), with international and government companies leading the way. This may have been because international companies are more likely to hire employees with prior international experience.

Industrial and infrastructure/heavy engineering construction companies had a significant lead in terms of the numbers of participants working for them, irrespective of whether these participants had experience in construction projects outside the UAE (Figure 4.9b). This reflects the fact that participants from companies with industrial (79 participants) and infrastructure/heavy engineering (94 participants) key types of activities dominated the sample of 237 participants. This domination extended over both sub-samples; that is, those with and without experience outside of the UAE.

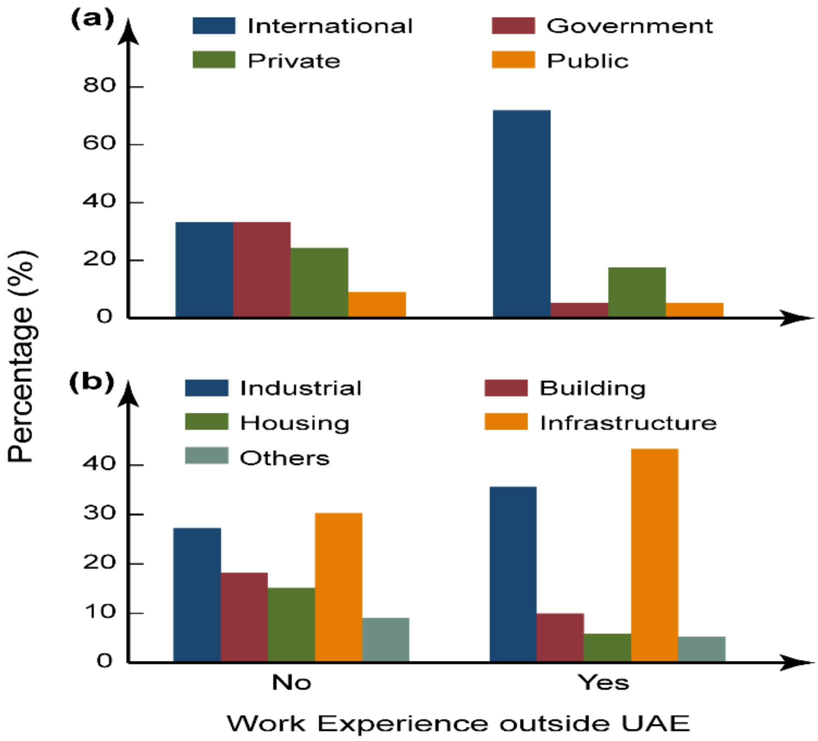


Figure 4.9: Relationships between Q17, Q18 and Q16

The histograms for count percentages in different categories (indicated by different colours) of the demographic variables are shown in Figure 4.9: (a) Q17 ('Company ownership') and (b) Q18 ('What the key activities of your organization?') versus the categorical variable Q16 ('Have you ever worked in a construction project in a country other than the UAE?') with the two categories 'No' (66 responses) and 'Yes' (171 responses) on the horizontal axes.

4.4 Numerical Variables—Correlations

There were 68 numerical variables measured using the survey instrument on a Likert scale of 1–5, except for variables Q35 and Q38–Q40 were on a 1–4 scale, Q23 and Q27–Q28 were on a 1–3 scale, and Q24 and Q36–37 were 'yes-or-no' type questions, (Appendix 4). Many of these variables were significantly correlated with each other. Simple correlations for selected pairs of numerous numerical variables measured using a survey instrument cannot usually be used for the reliable characterisation of relationships or effects between these variables. This is because other numerical variables may significantly influence correlations within any selected pair of variables. In this case, those 'other numerical variables' will work as confounders for the correlations between the selected two variables. Therefore, the development of a statistical model that involves many of these variables and adjusts for the effects of the involved variables is essential to consider any confounding effects of the variables on each other. Chapter 3 provided a more detailed and justified discussion of confounding effects.

Despite this significant reservation about the validity and value of simple correlations between different numerical variables measured using a survey instrument, the preliminary determination of such correlations could still be useful in identifying potential relationships between the variables. This could provide useful indications for the development of statistical models.

Pearson correlations are the most commonly used type of correlations (De Winter *et al.*, 2016: Larsen & Marx, 2012). However, their applicability conditions require the data to be normally distributed. This requirement is rarely satisfied for numerical variables measured using survey instruments. The normality tests (including the Shapiro–Wilk test and Tukey Ladder of Powers test) confirmed that the numerical data in this study were not normally distributed, which means that Pearson correlations cannot be used to determine and characterise any relationships between the 68 numerical variables.

As also explained in Chapter 3, an alternative to the Pearson correlation coefficient is the non-parametric Spearman rank correlation coefficient (Corder & Foreman, 2014). Spearman correlations are applicable to ordered data that may not be normally distributed, which is the case with the numerical variables in this study. The resultant simple Spearman rank correlation coefficients for all pairs of numerical variables considered in this study are presented in Table 4.3.

Based on the available sample size of 237 participants, the significance threshold for the calculated Spearman correlation coefficients was determined to be 0.13. Thus, only correlations characterised by coefficients greater than 0.13 or less than −0.13 are statistically significant (Tables 4.3a–e). Insignificant coefficients are crossed out in the white boxes of Tables 4.3a–e. Some of the coefficients indicated at the 0.13 level are crossed out, and some are not (Tables 4.3a–e). Thus, those that are crossed out are below 0.13 but rounded up to 0.13, whereas those that are not crossed out are larger than the threshold of 0.13 but rounded down to 0.13. Green shading in Tables 4.3a–e indicates significant Spearman correlation coefficients and red shading indicates the coefficients that are particularly significant and greater than 0.4.

Table 4.3a: Correlation Table 1

	Q20	Q22	Q25.1	Q25.2	Q25.3	Q25.4	Q25.5	Q29.1	Q29.2	Q29.3	Q29.4	Q29.5	Q29.6	Q29.7
Q20	1													
Q22	0.43	1.00												
Q25.1	-0.05	0.05	1.00											
Q25.2	-0.11	-0.15	-0.14	1.00										
Q25.3	-0.02	-0.19	-0.14	0.22	1.00									
Q25.4	0.05	-0.12	-0.08	0.17	0.23	1.00								
Q25.5	-0.13	-0.15	0.13	0.15	0.10	0.05	1.00							
Q29.1	-0.02	-0.20	-0.25	0.26	0.29	0.29	0.16	1.00						
Q29.2	-0.07	-0.20	-0.04	0.16	0.29	0.23	0.08	0.22	1.00					
Q29.3	0.08	0.07	-0.15	0.05	0.03	0.04	0.13	0.23	0.03	1.00				
Q29.4	0.08	-0.19	-0.41	0.18	0.28	0.22	0.05	0.45	0.16	0.20	1.00			
Q29.5	-0.02	-0.14	0.03	0.09	0.25	0.27	0.09	0.26	0.22	0.10	0.16	1.00		
Q29.6	-0.10	-0.22	-0.17	0.20	0.28	0.22	0.13	0.40	0.27	0.12	0.29	0.10	1.00	
Q29.7	-0.01	-0.22	-0.12	0.23	0.32	0.28	0.09	0.25	0.41	0.15	0.20	0.33	0.25	1.00
Q29.8	0.01	-0.06	-0.01	0.13	0.26	0.25	0.20	0.37	0.22	0.22	0.41	0.27	0.35	0.30
Q29.9	-0.01	0.02	0.09	0.02	0.00	0.01	0.14	0.12	0.08	0.23	0.02	0.18	0.08	0.11
Q29.10	-0.03	-0.24	-0.30	0.22	0.33	0.32	0.15	0.44	0.25	0.19	0.54	0.24	0.38	0.30
Q29.11	-0.07	-0.21	-0.18	0.19	0.24	0.29	0.10	0.31	0.24	0.11	0.46	0.31	0.43	0.33
Q29.12	-0.01	-0.25	-0.32	0.27	0.46	0.34	0.12	0.45	0.26	0.19	0.55	0.23	0.54	0.40
Q29.13	-0.01	-0.07	0.11	0.06	0.14	0.08	0.13	0.09	0.09	0.00	0.03	0.16	0.14	0.28
Q29.14	0.06	-0.22	-0.30	0.21	0.37	0.27	0.15	0.47	0.33	0.29	0.56	0.35	0.33	0.42
Q29.15	-0.03	-0.24	-0.34	0.24	0.36	0.23	0.07	0.48	0.21	0.17	0.59	0.24	0.33	0.26
Q30.1	0.05	-0.23	-0.42	0.21	0.37	0.30	0.11	0.49	0.18	0.16	0.59	0.23	0.41	0.33
Q30.2	-0.05	-0.21	0.01	0.12	0.24	0.16	0.13	0.20	0.19	0.12	0.24	0.22	0.30	0.24
Q30.3	0.03	-0.19	-0.23	0.18	0.31	0.31	0.19	0.48	0.25	0.20	0.49	0.28	0.43	0.33
Q30.4	-0.10	-0.12	0.13	0.16	0.01	0.09	0.09	0.04	0.15	-0.04	0.02	0.21	0.09	0.21

	Q20	Q22	Q25.1	Q25.2	Q25.3	Q25.4	Q25.5	Q29.1	Q29.2	Q29.3	Q29.4	Q29.5	Q29.6	Q29.7
Q30.5	0.04	-0.23	-0.18	0.31	0.40	0.31	0.20	0.41	0.37	0.13	0.39	0.25	0.41	0.43
Q30.6	-0.04	-0.18	-0.31	0.14	0.20	0.19	0.06	0.31	0.16	0.17	0.45	0.28	0.29	0.25
Q30.7	-0.02	-0.17	-0.02	0.04	0.23	0.29	0.14	0.26	0.22	0.08	0.33	0.19	0.34	0.25
Q30.8	0.07	-0.12	-0.34	0.15	0.30	0.20	0.12	0.38	0.14	0.24	0.50	0.12	0.28	0.21
Q30.9	0.02	-0.03	-0.16	0.14	0.21	0.26	-0.02	0.25	0.18	-0.07	0.25	0.06	0.15	0.18
Q30.10	-0.03	-0.26	-0.34	0.24	0.37	0.33	0.14	0.44	0.27	0.28	0.50	0.23	0.52	0.34
Q30.11	-0.07	-0.24	-0.20	0.18	0.37	0.23	0.17	0.32	0.29	-0.01	0.39	0.32	0.26	0.35
Q30.12	0.04	-0.21	-0.36	0.25	0.26	0.31	0.15	0.38	0.31	0.25	0.49	0.24	0.38	0.32
Q30.13	0.08	-0.22	-0.33	0.08	0.30	0.27	0.11	0.35	0.21	0.15	0.58	0.21	0.37	0.34
Q30.14	-0.06	-0.27	0.15	0.21	0.16	0.18	0.18	0.11	0.24	0.10	0.10	0.25	0.26	0.27
Q31.1	-0.10	-0.16	0.05	0.08	0.09	0.12	-0.07	0.05	0.22	-0.03	0.05	0.21	0.12	0.18
Q31.2	-0.13	-0.13	-0.02	0.08	-0.02	0.11	0.04	0.09	0.10	-0.04	-0.02	0.06	-0.05	0.29
Q31.3	-0.08	-0.19	-0.23	0.25	0.34	0.14	0.15	0.40	0.24	0.04	0.35	0.12	0.24	0.22
Q31.4	0.09	0.05	-0.04	-0.16	-0.02	-0.09	-0.11	-0.05	-0.14	0.14	-0.02	-0.06	0.02	-0.09
Q31.5	-0.08	-0.32	-0.16	0.23	0.31	0.26	0.14	0.22	0.34	0.08	0.42	0.28	0.25	0.37
Q31.6	-0.03	0.04	0.29	-0.13	-0.12	-0.19	0.02	-0.37	-0.09	-0.06	-0.38	-0.15	-0.26	-0.22
Q31.7	0.08	0.20	0.30	-0.16	-0.30	-0.23	-0.05	-0.39	-0.22	-0.11	-0.39	-0.20	-0.34	-0.28
Q31.8	-0.06	-0.27	-0.13	0.17	0.23	0.26	0.19	0.41	0.31	0.21	0.47	0.32	0.39	0.38
Q31.9	0.03	-0.24	-0.17	0.23	0.30	0.21	0.17	0.23	0.17	0.14	0.33	0.17	0.23	0.26
Q31.10	0.01	-0.22	-0.21	0.21	0.40	0.25	0.23	0.39	0.28	0.26	0.45	0.27	0.39	0.42
Q31.11	-0.11	-0.22	0.13	0.16	0.12	0.25	0.19	0.12	0.23	-0.06	0.06	0.22	0.22	0.26
Q31.12	-0.10	-0.28	-0.22	0.29	0.42	0.22	0.17	0.46	0.40	0.19	0.46	0.28	0.36	0.38
Q31.13	-0.06	-0.06	0.02	0.09	0.07	-0.04	-0.01	0.06	0.08	-0.01	-0.03	0.17	-0.14	0.10
Q31.14	-0.03	-0.22	-0.14	0.19	0.32	0.18	0.09	0.31	0.31	0.14	0.28	0.09	0.19	0.31
Q31.15	-0.13	0.03	0.30	-0.03	-0.18	-0.17	0.09	-0.23	0.03	-0.08	-0.31	-0.08	-0.16	-0.19
Q31.16	0.00	-0.19	0.06	0.18	0.19	0.18	0.07	0.24	0.24	0.14	0.09	0.25	0.21	0.33
Q31.17	-0.09	-0.22	-0.15	0.28	0.27	0.23	0.14	0.41	0.26	0.16	0.33	0.23	0.29	0.33

	Q20	Q22	Q25.1	Q25.2	Q25.3	Q25.4	Q25.5	Q29.1	Q29.2	Q29.3	Q29.4	Q29.5	Q29.6	Q29.7
Q31.18	-0.08	-0.19	-0.03	0.21	0.25	0.22	0.11	0.19	0.24	0.02	0.11	0.30	0.20	0.30
Q31.19	-0.01	-0.10	-0.15	0.15	0.24	0.19	0.18	0.32	0.20	0.25	0.36	0.18	0.37	0.29
Q34.1	-0.01	0.18	0.24	-0.18	-0.27	-0.16	-0.18	-0.27	-0.26	-0.14	-0.33	-0.14	-0.27	-0.27
Q34.2	0.08	0.23	0.29	-0.18	-0.26	-0.31	-0.12	-0.32	-0.15	-0.08	-0.39	-0.12	-0.35	-0.19
Q34.3	0.06	0.14	-0.09	-0.18	-0.15	-0.06	-0.07	-0.05	-0.07	0.04	0.08	-0.07	-0.03	-0.12
Q34.4	-0.02	0.28	0.33	-0.23	-0.32	-0.29	-0.20	-0.46	-0.26	-0.21	-0.46	-0.24	-0.45	-0.37
Q34.5	0.09	0.01	-0.14	-0.03	0.08	0.02	-0.05	0.02	0.03	0.09	0.19	-0.07	0.10	0.00
Q34.6	0.12	0.11	-0.13	-0.08	0.01	-0.09	0.00	-0.09	0.02	-0.05	0.00	-0.10	0.00	-0.13
Q34.7	-0.06	0.09	0.33	-0.13	-0.32	-0.13	-0.03	-0.28	-0.18	-0.20	-0.37	-0.08	-0.29	-0.23
Q34.8	-0.01	0.02	-0.22	0.07	0.05	0.04	0.00	0.15	0.00	0.09	0.24	0.09	0.19	0.14
Q34.9	-0.04	0.09	0.00	-0.08	-0.05	-0.04	-0.07	-0.14	-0.08	0.04	-0.12	-0.05	-0.14	-0.09
Q35	0.10	0.28	0.03	-0.15	-0.21	-0.16	-0.16	-0.32	-0.17	-0.02	-0.25	-0.13	-0.32	-0.20
Q38	0.10	0.24	0.19	-0.18	-0.23	-0.28	-0.30	-0.35	-0.23	-0.16	-0.31	-0.13	-0.37	-0.31
Q39	0.09	0.32	0.17	-0.25	-0.35	-0.25	-0.30	-0.45	-0.20	-0.15	-0.43	-0.20	-0.47	-0.37
Q40	0.04	0.30	0.29	-0.24	-0.32	-0.23	-0.25	-0.40	-0.17	-0.15	-0.45	-0.14	-0.38	-0.26

Table 4.3b: Correlation Table 2

	Q29.8	Q29.9	Q29.10	Q29.11	Q29.12	Q29.13	Q29.14	Q29.15	Q30.1	Q30.2	Q30.3	Q30.4	Q30.5	Q30.6
Q29.8	1.00													
Q29.9	0.13	1.00												
Q29.10	0.32	0.02	1.00											
Q29.11	0.36	0.16	0.33	1.00										
Q29.12	0.46	-0.02	0.55	0.46	1.00									
Q29.13	0.21	0.08	0.09	0.20	0.18	1.00								
Q29.14	0.38	0.22	0.56	0.41	0.54	0.07	1.00							
Q29.15	0.28	0.15	0.58	0.37	0.44	0.00	0.53	1.00						
Q30.1	0.34	0.05	0.53	0.46	0.60	0.13	0.57	0.55	1.00					
Q30.2	0.35	0.25	0.21	0.29	0.29	0.08	0.29	0.24	0.16	1.00				
Q30.3	0.31	0.11	0.45	0.50	0.52	0.13	0.54	0.42	0.56	0.19	1.00			
Q30.4	0.08	0.11	0.03	0.18	0.11	0.24	0.10	0.07	0.04	0.12	0.07	1.00		
Q30.5	0.39	0.18	0.47	0.45	0.46	0.12	0.53	0.43	0.42	0.32	0.42	0.07	1.00	
Q30.6	0.26	0.14	0.38	0.30	0.35	0.12	0.43	0.53	0.38	0.29	0.36	0.03	0.27	1.00
Q30.7	0.28	0.07	0.30	0.35	0.41	0.10	0.27	0.21	0.35	0.22	0.38	0.19	0.28	0.08
Q30.8	0.22	0.10	0.53	0.31	0.40	-0.01	0.49	0.52	0.54	0.27	0.43	-0.10	0.35	0.48
Q30.9	0.20	0.03	0.11	0.19	0.21	0.05	0.13	0.24	0.30	0.02	0.21	0.16	0.19	0.11
Q30.10	0.36	0.09	0.53	0.42	0.59	0.09	0.59	0.51	0.61	0.26	0.60	0.03	0.42	0.44
Q30.11	0.32	-0.04	0.36	0.37	0.48	0.07	0.48	0.35	0.37	0.25	0.36	0.13	0.36	0.23
Q30.12	0.29	0.16	0.45	0.45	0.47	0.04	0.59	0.44	0.60	0.22	0.57	0.04	0.43	0.36
Q30.13	0.34	0.08	0.51	0.50	0.60	0.10	0.59	0.44	0.65	0.24	0.58	-0.01	0.38	0.42
Q30.14	0.27	0.25	0.17	0.24	0.21	0.12	0.19	0.14	0.13	0.30	0.24	0.28	0.34	0.14
Q31.1	-0.03	0.10	0.03	0.12	0.13	0.03	0.02	0.10	0.02	0.15	0.07	0.25	0.14	0.12
Q31.2	0.04	-0.05	-0.03	0.00	0.03	0.11	-0.02	0.07	-0.01	0.02	0.02	0.12	0.03	0.05
Q31.3	0.19	0.03	0.43	0.31	0.41	0.13	0.47	0.41	0.46	0.13	0.33	0.03	0.41	0.22
Q31.4	0.00	0.02	0.08	-0.09	0.00	-0.06	0.03	0.01	-0.03	0.14	-0.10	-0.23	-0.01	-0.01

Q31.5	0.32	0.06	0.41	0.37	0.47	0.07	0.45	0.29	0.38	0.24	0.42	0.14	0.37	0.27
Q31.6	-0.22	-0.02	-0.25	-0.34	-0.36	-0.04	-0.33	-0.25	-0.47	-0.06	-0.35	-0.06	-0.20	-0.13
Q31.7	-0.29	0.00	-0.35	-0.40	-0.51	-0.09	-0.40	-0.37	-0.48	-0.15	-0.45	0.02	-0.30	-0.31
Q31.8	0.41	0.17	0.42	0.49	0.45	0.21	0.54	0.35	0.45	0.34	0.51	0.21	0.43	0.29
Q31.9	0.29	0.19	0.24	0.24	0.38	0.14	0.35	0.35	0.34	0.29	0.30	0.08	0.45	0.36
Q31.10	0.40	0.08	0.45	0.37	0.53	0.19	0.62	0.41	0.53	0.26	0.48	0.15	0.49	0.30
Q31.11	0.19	0.10	0.12	0.23	0.19	0.07	0.08	0.16	0.11	0.20	0.20	0.26	0.21	0.03
Q31.12	0.37	0.14	0.51	0.33	0.54	0.10	0.61	0.42	0.45	0.30	0.50	0.13	0.50	0.28
Q31.13	0.02	0.10	-0.03	-0.01	-0.10	-0.04	0.02	0.06	-0.05	0.02	-0.08	0.11	0.06	0.00
Q31.14	0.21	-0.03	0.46	0.16	0.34	0.14	0.35	0.33	0.34	0.10	0.24	0.07	0.21	0.21
Q31.15	-0.15	-0.06	-0.17	-0.20	-0.23	0.01	-0.21	-0.35	-0.36	-0.08	-0.25	0.14	-0.18	-0.21
Q31.16	0.20	0.20	0.20	0.20	0.21	0.17	0.27	0.22	0.19	0.21	0.17	0.16	0.33	0.17
Q31.17	0.29	0.16	0.39	0.28	0.43	0.07	0.43	0.39	0.39	0.27	0.33	0.02	0.30	0.19
Q31.18	0.24	0.10	0.13	0.13	0.23	0.03	0.23	0.26	0.18	0.17	0.19	0.10	0.30	0.11
Q31.19	0.27	0.09	0.39	0.33	0.45	0.12	0.42	0.33	0.40	0.26	0.50	0.12	0.30	0.21
Q34.1	-0.22	-0.10	-0.40	-0.25	-0.33	-0.07	-0.47	-0.28	-0.34	-0.13	-0.29	-0.08	-0.31	-0.19
Q34.2	-0.24	0.09	-0.30	-0.35	-0.39	-0.04	-0.37	-0.36	-0.39	-0.09	-0.41	-0.02	-0.33	-0.29
Q34.3	-0.01	-0.01	-0.05	0.01	-0.08	-0.06	0.02	-0.04	-0.03	-0.14	0.02	-0.12	-0.18	0.05
Q34.4	-0.32	-0.01	-0.52	-0.35	-0.63	-0.08	-0.53	-0.46	-0.55	-0.30	-0.46	-0.09	-0.42	-0.36
Q34.5	0.08	-0.02	0.19	0.08	0.16	0.07	0.10	0.15	0.21	0.16	0.11	-0.23	0.19	0.09
Q34.6	-0.01	-0.04	-0.04	0.00	-0.11	-0.05	0.01	-0.14	-0.04	-0.08	-0.03	-0.11	-0.08	-0.02
Q34.7	-0.20	-0.03	-0.41	-0.31	-0.43	-0.09	-0.40	-0.39	-0.43	-0.10	-0.30	0.11	-0.37	-0.30
Q34.8	0.13	0.05	0.24	0.29	0.20	-0.08	0.29	0.24	0.28	0.11	0.25	-0.16	0.23	0.18
Q34.9	-0.18	-0.10	-0.15	-0.08	-0.15	0.01	-0.15	-0.14	-0.15	-0.03	-0.20	-0.02	-0.14	-0.04
Q35	-0.20	-0.14	-0.19	-0.22	-0.32	-0.14	-0.27	-0.20	-0.22	-0.15	-0.36	-0.19	-0.20	-0.18
Q38	-0.27	-0.12	-0.35	-0.32	-0.44	-0.16	-0.41	-0.29	-0.36	-0.21	-0.41	-0.09	-0.36	-0.28
Q39	-0.33	-0.15	-0.44	-0.45	-0.53	-0.24	-0.49	-0.39	-0.50	-0.24	-0.50	-0.08	-0.39	-0.29
Q40	-0.32	-0.04	-0.38	-0.37	-0.49	-0.19	-0.44	-0.39	-0.47	-0.18	-0.46	-0.14	-0.37	-0.33

Table 4.3c: Correlation Table 3

	Q30.7	Q30.8	Q30.9	Q30.10	Q30.11	Q30.12	Q30.13	Q30.14	Q31.1	Q31.2	Q31.3	Q31.4	Q31.5	Q31.6
Q30.7	1.00													
Q30.8	0.21	1.00												
Q30.9	0.17	-0.03	1.00											
Q30.10	0.38	0.50	0.14	1.00										
Q30.11	0.23	0.23	0.22	0.37	1.00									
Q30.12	0.31	0.49	0.10	0.65	0.29	1.00								
Q30.13	0.37	0.54	0.16	0.62	0.39	0.55	1.00							
Q30.14	0.30	0.03	0.06	0.27	0.18	0.27	0.16	1.00						
Q31.1	0.17	-0.07	0.10	0.07	0.08	0.03	0.02	0.21	1.00					
Q31.2	0.09	-0.10	0.10	0.03	0.06	-0.01	-0.06	0.09	0.28	1.00				
Q31.3	0.21	0.39	0.13	0.40	0.32	0.42	0.36	0.07	0.20	0.08	1.00			
Q31.4	-0.03	0.18	-0.21	0.03	-0.06	-0.06	0.04	-0.10	-0.13	-0.33	-0.14	1.00		
Q31.5	0.23	0.26	0.17	0.39	0.39	0.43	0.48	0.29	0.21	0.14	0.33	-0.15	1.00	
Q31.6	-0.20	-0.25	-0.27	-0.32	-0.13	-0.30	-0.45	-0.04	0.05	-0.12	-0.19	0.15	-0.31	1.00
Q31.7	-0.19	-0.34	-0.16	-0.50	-0.34	-0.39	-0.52	-0.12	-0.03	-0.16	-0.33	0.08	-0.37	0.43
Q31.8	0.35	0.28	0.24	0.54	0.44	0.47	0.53	0.36	0.13	0.13	0.37	-0.07	0.49	-0.40
Q31.9	0.16	0.26	0.17	0.38	0.25	0.30	0.19	0.21	0.15	0.11	0.30	-0.07	0.24	0.01
Q31.10	0.37	0.42	0.23	0.63	0.44	0.53	0.48	0.32	0.09	0.06	0.40	0.05	0.38	-0.29
Q31.11	0.18	-0.05	0.20	0.12	0.24	0.17	0.06	0.37	0.18	0.21	0.18	-0.25	0.28	-0.09
Q31.12	0.34	0.38	0.10	0.50	0.41	0.59	0.48	0.33	0.11	0.04	0.38	-0.09	0.47	-0.26
Q31.13	0.04	-0.16	0.13	-0.07	-0.04	-0.08	-0.13	0.21	0.11	0.15	-0.02	-0.07	0.05	0.10
Q31.14	0.21	0.23	0.14	0.36	0.22	0.32	0.25	0.18	0.06	0.17	0.35	-0.12	0.30	-0.21
Q31.15	-0.09	-0.32	-0.19	-0.32	-0.14	-0.22	-0.33	0.02	0.01	0.03	-0.13	0.01	0.00	0.32
Q31.16	0.18	0.07	0.16	0.23	0.24	0.18	0.10	0.27	0.23	0.07	0.13	-0.02	0.24	-0.06
Q31.17	0.29	0.31	0.07	0.40	0.34	0.34	0.35	0.21	0.15	0.12	0.31	-0.03	0.28	-0.23

Q31.18	0.22	0.02	0.12	0.31	0.28	0.19	0.09	0.32	0.15	0.25	0.22	-0.12	0.20	-0.14
Q31.19	0.35	0.27	0.11	0.47	0.33	0.37	0.44	0.19	0.15	0.08	0.28	0.01	0.35	-0.23
Q34.1	-0.14	-0.26	-0.08	-0.43	-0.25	-0.37	-0.33	-0.14	-0.04	-0.05	-0.27	0.13	-0.25	0.25
Q34.2	-0.23	-0.30	-0.30	-0.47	-0.29	-0.42	-0.40	-0.15	-0.02	-0.09	-0.25	0.04	-0.18	0.31
Q34.3	-0.04	0.12	-0.14	0.00	-0.17	0.00	0.05	-0.14	-0.19	-0.12	-0.12	0.17	-0.21	0.01
Q34.4	-0.28	-0.43	-0.11	-0.62	-0.43	-0.56	-0.53	-0.21	-0.08	-0.07	-0.47	0.02	-0.39	0.24
Q34.5	0.01	0.29	-0.05	0.16	0.01	0.17	0.21	-0.07	-0.13	-0.25	0.08	0.25	-0.09	-0.10
Q34.6	-0.04	0.10	-0.04	0.01	-0.10	0.00	0.00	-0.08	-0.13	-0.21	0.01	0.00	-0.09	0.01
Q34.7	-0.11	-0.41	-0.07	-0.40	-0.30	-0.37	-0.38	-0.05	-0.03	0.07	-0.45	0.01	-0.24	0.26
Q34.8	0.11	0.23	-0.06	0.23	0.19	0.21	0.33	-0.06	-0.10	-0.14	0.06	0.19	0.04	-0.19
Q34.9	-0.18	-0.09	-0.13	-0.21	-0.08	-0.11	-0.21	-0.21	0.01	-0.03	-0.03	0.04	-0.23	0.16
Q35	-0.30	-0.22	-0.02	-0.35	-0.20	-0.29	-0.30	-0.14	-0.07	-0.05	-0.18	0.11	-0.23	0.19
Q38	-0.28	-0.37	-0.06	-0.50	-0.28	-0.44	-0.43	-0.20	-0.05	0.01	-0.32	0.00	-0.30	0.25
Q39	-0.38	-0.37	-0.16	-0.60	-0.33	-0.50	-0.50	-0.21	-0.04	0.02	-0.38	0.00	-0.40	0.28
Q40	-0.33	-0.45	-0.13	-0.57	-0.33	-0.45	-0.50	-0.18	0.01	-0.01	-0.32	0.01	-0.32	0.30

Table 4.3d: Correlation Table 4

	Q31.7	Q31.8	Q31.9	Q31.10	Q31.11	Q31.12	Q31.13	Q31.14	Q31.15	Q31.16	Q31.17	Q31.18	Q31.19	Q34.1
Q31.7	1.00													
Q31.8	-0.45	1.00												
Q31.9	-0.14	0.20	1.00											
Q31.10	-0.35	0.48	0.32	1.00										
Q31.11	-0.06	0.15	0.22	0.12	1.00									
Q31.12	-0.37	0.51	0.31	0.48	0.19	1.00								
Q31.13	0.12	0.04	0.05	-0.01	0.08	-0.02	1.00							
Q31.14	-0.23	0.30	0.25	0.37	0.25	0.41	0.02	1.00						
Q31.15	0.32	-0.10	-0.16	-0.25	-0.07	-0.11	0.09	-0.11	1.00					
Q31.16	-0.08	0.31	0.24	0.29	0.20	0.33	0.19	0.18	-0.12	1.00				
Q31.17	-0.30	0.37	0.16	0.36	0.15	0.44	0.04	0.27	-0.16	0.22	1.00			
Q31.18	-0.21	0.29	0.25	0.27	0.27	0.31	0.13	0.23	-0.08	0.22	0.24	1.00		
Q31.19	-0.21	0.38	0.28	0.43	0.22	0.41	-0.12	0.28	-0.11	0.21	0.37	0.13	1.00	
Q34.1	0.31	-0.40	-0.19	-0.39	-0.08	-0.37	0.00	-0.26	0.22	-0.18	-0.30	-0.21	-0.14	1.00
Q34.2	0.29	-0.39	-0.22	-0.43	-0.11	-0.30	-0.02	-0.20	0.22	-0.11	-0.27	-0.21	-0.26	0.24
Q34.3	0.00	-0.11	-0.11	-0.04	-0.12	-0.12	-0.15	-0.06	-0.06	-0.21	-0.10	-0.05	0.01	0.06
Q34.4	0.44	-0.43	-0.35	-0.53	-0.25	-0.51	0.07	-0.33	0.17	-0.28	-0.43	-0.27	-0.44	0.39
Q34.5	-0.11	0.07	0.05	0.13	-0.15	0.08	-0.33	0.00	-0.19	-0.05	0.07	-0.12	0.19	0.05
Q34.6	0.04	-0.09	-0.01	-0.05	-0.14	-0.05	-0.01	-0.10	-0.09	-0.13	-0.06	-0.01	-0.09	-0.01
Q34.7	0.29	-0.27	-0.25	-0.41	-0.06	-0.37	0.07	-0.31	0.30	-0.11	-0.31	-0.11	-0.27	0.37
Q34.8	-0.20	0.23	0.02	0.13	-0.13	0.14	-0.16	-0.06	-0.14	-0.05	0.18	-0.07	0.20	-0.05
Q34.9	0.10	-0.14	-0.02	-0.25	-0.06	-0.22	-0.02	-0.09	0.00	-0.15	-0.11	-0.10	-0.08	0.11
Q35	0.16	-0.27	-0.24	-0.38	-0.20	-0.30	0.00	-0.19	0.15	-0.23	-0.15	-0.05	-0.26	0.24
Q38	0.34	-0.40	-0.23	-0.45	-0.19	-0.44	0.10	-0.24	0.17	-0.26	-0.28	-0.21	-0.25	0.31
Q39	0.41	-0.46	-0.26	-0.53	-0.19	-0.50	0.03	-0.31	0.24	-0.31	-0.36	-0.18	-0.41	0.36
Q40	0.37	-0.40	-0.22	-0.58	-0.12	-0.38	0.03	-0.25	0.25	-0.22	-0.30	-0.16	-0.33	0.34

Table 4.3e: Correlation Table 5

	Q34.2	Q34.3	Q34.4	Q34.5	Q34.6	Q34.7	Q34.8	Q34.9	Q35	Q38	Q39	Q40
Q34.2	1.00											
Q34.3	-0.11	1.00										
Q34.4	0.33	0.05	1.00									
Q34.5	-0.16	0.11	-0.11	1.00								
Q34.6	-0.07	0.14	0.10	0.07	1.00							
Q34.7	0.29	-0.06	0.46	-0.16	-0.05	1.00						
Q34.8	-0.15	0.08	-0.17	0.31	-0.05	-0.19	1.00					
Q34.9	0.08	0.12	0.07	0.05	0.00	-0.06	-0.07	1.00				
Q35	0.14	0.00	0.30	0.09	0.14	0.10	-0.03	0.15	1.00			
Q38	0.34	0.05	0.39	-0.03	-0.01	0.30	-0.12	0.17	0.57	1.00		
Q39	0.31	0.16	0.50	-0.01	0.04	0.35	-0.22	0.15	0.53	0.69	1.00	
Q40	0.40	0.03	0.47	-0.06	0.09	0.35	-0.17	0.19	0.53	0.65	0.69	1.00

Large Spearman correlation coefficients could indicate that there are potential relationships between the variables. The variables could be associated with the same construct or belong to two different constructs that are causally related to each other. For example, variables Q35, Q38, Q39 and Q40 are characterised by large correlation coefficients (Table 4.3e). According to the content of these items (Appendix 4), they could be associated with a construct called 'project success'. This expectation will be mathematically confirmed below (Figure 5.2). Thus, the outcomes obtained in Tables 4.3a–e could be helpful in the preliminary identification of any potential constructs associated with the measured numerical variables.

Conversely, correlated items that intuitively do not belong to the same construct could indicate a significant relationship between the two constructs to which the two variables belong. For example, variables Q30.1 ('Examining the financial resources liability/employer's financial liability') and Q30.12 ('Efficient/timely procurement of materials and equipment') are likely to belong to different constructs that could be termed as 'contract importance' and 'resources and technology (R&T) importance' respectively (see Figures 5.7 and 5.8). The large and strongly significant positive correlation coefficient of 0.60 between Q30.1 and Q30.12 suggests that there might be a significant positive relationship between the constructs of contract importance and R&T importance.

This proposition finds further confirmation in the large and positive correlation coefficient of 0.62 between variables and Q30.13 ('Good forecasting of work plan/estimation of project duration') and Q30.10 ('Good financial accountability and management') (Table 4.3c). These variables are again likely to belong to the constructs of contract importance and R&T importance (which is confirmed below; see Figures 5.7 and 5.8). Therefore, significant correlations between Q30.13 and Q30.10 further suggest a possible relationship between the constructs of contract importance and R&T importance, which was indeed the case (see Figure 5.20).

Any potential constructs or relationships between the constructs and/or variables derived from Tables 4.3a–e should be treated only as preliminary indications of possible relationships because the simple Spearman correlation coefficients (Tables 4.3a–e) are not adjusted for any other variables and may only indicate *potential* relationships. Any such indications must be validated and confirmed through the appropriate models in which any relationships are adjusted for other involved variables. Similarly, any expected constructs based on intuitive considerations and/or values of the Spearman correlation coefficients (Tables 4.3a–e) must be confirmed through the factor analyses and evaluation of internal consistency (Chapter 5).

4.5 Numerical Variables—Group Comparisons

Preliminary group comparisons for the numerical variables could be conducted for different categories of the demographic and/or company variables. Given the non-normal distributions of the numerical variables, *t*-tests and ANOVA are not applicable for summary statistics analysis.

Non-parametric tests for group comparisons should be used, which are applicable for analysis of groups with non-normal data distributions. The main non-parametric test replacing ANOVA for the data with non-normal distributions is the Kruskal–Wallis test (Corder & Foreman, 2014; Richardson, 2010; Sprent & Smeeton, 2016). Like ANOVA, the Kruskal–Wallis test determines whether there are any statistically significant differences in the answers to numerical survey items among groups of participants corresponding to several categories of a categorical variable.

The Kruskal–Wallis test was used to consider differences among the responses of different groups of participants corresponding to different categories of demographic and company variables. Given a large number of measured numerical variables (68 in total), only their representative examples were used for the summary statistics analysis. These examples included the following 11 numerical variables: Q29.4, Q29.10, Q29.12, Q30.1, Q30.8, Q30.10, Q30.13, Q31.1, Q31.8, Q31.14 and Q38.

Each variable was intuitively expected to be associated with different factors/constructs. This association was later confirmed using CFA modelling (Chapter 5). In addition to this, each variable had a large factor loading in the respective construct (compared with the other associated variables), which made the selected variables highly relevant to the developed constructs. As a result, the selected 11 variables were regarded as good examples to demonstrate group comparisons.

Table 4.4 shows the outcomes of the described group comparison using the Kruskal–Wallis test for the selected 11 representative examples of numerical variables. The *p*-values were displayed if the differences in the answers of the participant groups corresponding to the different categories of the indicated categorical variables were significantly different (Table 4.4). The significance threshold for the calculated *p*-values was adopted at 0.05. If the calculated *p*-value was less than 0.05, the differences in the answers of the respective groups were statistically significant (at least for any two categories of the categorical variable). The respective *p*-values are shown in Table 4.4.

However, if the calculated *p*-value was greater than 0.05, the differences in the answers of the respective groups were not statistically significant, and the corresponding *p*-values are not shown in Table 4.4.

Table 4.4: Kruskal–Wallis Test Results

Survey items	Categorical variables	*p*-values	Test significance
Q29.4	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	0.03	Significant
	Q17	-	
	Q18	0.002	Significant
Q29.10	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	0.02	Significant
Q29.12	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	0.002	Significant
Q30.1	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	0.05	Significant
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	-	
Q30.8	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	0.015	Significant
	Q13	-	
	Q16	-	
	Q17	0.036	Significant
	Q18	-	

Table 4.4: Kruskal–Wallis Test Results Continued

Survey items	Categorical variables	*p*-values	Test significance
Q30.10	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	0.007	Significant
Q30.13	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	-	
Q31.1	Q1	-	
	Q2	-	
	Q3	-	
	Q4	-	
	Q9	0.049	Significant
	Q13	-	
	Q16	0.045	Significant
	Q17	-	
	Q18	0.049	Significant
Q31.8	Q1	-	
	Q2	< 0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	-	
Q31.14	Q1	-	
	Q2	-	
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	-	
Q38	Q1	-	
	Q2	0.001	Significant
	Q3	-	
	Q4	-	
	Q9	-	
	Q13	-	
	Q16	-	
	Q17	-	
	Q18	0.048	Significant

The mean values (mean responses) of the numerical variables and their standard deviations are presented in Table 4.5; that is, for the combinations of numerical and categorical variables with significant outcomes of the Kruskal–Wallis test (Table 4.4).

Table 4.5: Mean Values for Groups

Numerical items	Categorical items	Categories	Mean values: numerical items	St. dev.
Q29.4	Q2	> 20 years	4.05	1.02
		16-20 years	4.33	1.00
		11-15 years	3.36	1.03
		6-10 years	3.17	0.79
		< 6 years	3.22	1.11
	Q16	No	3.95	1.07
		Yes	3.60	1.07
	Q18	Industrial	3.87	1.05
		Building	3.07	1.07
		Housing	3.30	0.92
		Infrastructure	3.74	1.07
		Others	4.2	0.94
Q29.10	Q2	> 20 years	4.01	1.27
		16-20 years	4.33	1.12
		11-15 years	3.05	1.41
		6-10 years	3.17	1.40
		< 6 years	3.22	1.59
	Q18	Industrial	3.68	1.34
		Building	3.17	1.39
		Housing	2.85	1.42
		Infrastructure	3.76	1.45
		Others	4.20	1.26
Q29.12	Q2	> 20 years	4.38	0.92
		16-20 years	4.70	0.69
		11-15 years	4.00	0.79
		6-10 years	4.09	0.78
		< 6 years	3.83	1.29
	Q18	Industrial	4.47	0.68
		Building	3.72	1.19
		Housing	3.80	1.06
		Infrastructure	4.24	0.86
		Others	4.67	0.62
Q30.1	Q2	> 20 years	4.03	1.14
		16-20 years	4.65	0.66
		11-15 years	3.55	1.16
		6-10 years	3.23	0.87
		< 6 years	3.50	1.38
	Q4	Asian	3.58	1.17
		Emirati	3.86	1.21
		European	3.81	1.06
		Middle Eastern	4.35	0.98
		North American	3.92	1.12
		Others	4.14	1.08
		South American	3.33	1.32

Table 4.5: Mean Values for Groups Continued

Numerical items	Categorical items	Categories	Mean values: numerical items	St. dev.
Q30.8	Q2	> 20 years	3.07	1.40
		16-20 years	3.70	1.07
		11-15 years	2.05	1.12
		6-10 years	2.36	1.29
		< 6 years	2.67	1.28
	Q9	Asia	2.86	1.42
		Europe	2.74	1.34
		Middle East	2.70	1.31
		North America	2.42	1.16
		Others	3.63	1.21
		South America	1.00	0
		UAE	2.48	1.41
	Q17	International	3.87	1.36
		Government	2.45	1.36
		Private	2.41	1.38
		Public	3.47	1.13
Q30.10	Q2	> 20 years	4.18	1.13
		16-20 years	4.60	0.78
		11-15 years	3.66	1.00
		6-10 years	3.60	0.88
		< 6 years	3.56	1.15
	Q18	Industrial	4.14	0.98
		Building	3.31	1.31
		Housing	3.65	0.81
		Infrastructure	4.05	0.94
		Others	4.20	1.42
Q30.13	Q2	> 20 years	3.82	1.30
		16-20 years	4.23	1.23
		11-15 years	2.91	1.32
		6-10 years	2.79	1.16
		< 6 years	3.33	1.33
Q31.1	Q9	Asia	4.17	0.98
		Europe	3.97	0.93
		Middle East	4.5	0.65
		North America	3.92	1.00
		Others	3.89	1.05
		South America	3.5	1.29
		UAE	4.30	1.06
	Q16	No	4.35	0.89
		Yes	4.08	0.96
	Q18	Industrial	4.34	0.86
		Building	3.66	1.04
		Housing	4.1	1.12
		Infrastructure	4.16	0.91
		Others	4.13	0.92
Q31.8	Q2	> 20 years	4.00	1.24
		16-20 years	4.48	0.99
		11-15 years	3.80	1.29
		6-10 years	3.26	1.24
		< 6 years	3.89	1.32
Q38	Q2	> 20 years	1.25	1.08
		16-20 years	0.85	0.98
		11-15 years	1.77	1.10
		6-10 years	1.38	1.05
		< 6 years	1.67	0.91
	Q18	Industrial	1.11	1.03
		Building	1.86	1.16
		Housing	1.45	1.10
		Infrastructure	1.40	1.08
		Others	1.33	1.05

Most of the numerical variables (except for Q23, Q24, Q27, Q28, and Q35-Q40) were measured on a 1–5 Likert scale. Therefore, mean values (responses) greater than 4 were regarded as quite high. Interestingly, five numerical items in Table 4.5 had mean values in all categories that were close to or exceeding 4, including Q29.4 (‘High rate of accidents during construction or operation phases’), Q29.12 (‘Inadequate forecast about market demand’), Q30.1 (‘Examining the financial resources liability/employer’s financial viability’), Q30.10 (‘Good financial accountability and management’) and Q31.1 (‘Emiratis value personal trust as an important ingredient in business transactions’).

Further, some items had mean scores that were significantly lower, such as Q30.8 (‘Use of efficient project-related technology’) and Q38 (‘The project scope was achieved?’). The low mean scores indicate that most participants evaluated achieving the project’s scope as low (Q38), and that the use of efficient technology was not typically considered a highly important aspect for the success of construction projects (Q30.8). In contrast, high scores indicated stronger perceptions about the criticality of site safety (Q29.4) and market demand (Q29.12), as well as the high importance of the financial liability and viability of contractors (Q30.1), efficient financial management (Q30.10) and the Emirati culture of doing business (Q31.1).

4.6 Conclusion

The summary statistics presented in this chapter describe and characterise the available sample, including its composition and any preliminary relationships. The correlations and significant differences between distinct groups of participants was also presented. As previously explained, these outcomes are not conclusive because they have not been adjusted for any other variables. Therefore, they can only be used as preliminary indications that might be instrumental and instructive in the development of statistical models that comprehensively describe the data and determine significant quantitative relationships.

For example, Table 4.5 shows that some of the survey items were characterised by larger mean scores, whereas other scores were quite low. Although this could indicate the potential differences of these items (and the associated levels of risk) in relation to their importance for project success, the differences could be caused by a skewed sample composition (e.g., by a significantly larger number of participants from contractor organisations) (Figure 4.1a) and/or the dominance of male participants (Figure 4.1c) and/or the dominance of participants from international construction companies (Figure 4.2a).

Proper adjustments for other variables as potential confounders could not be properly conducted within the framework of summary statistics, which primarily focused upon comparisons and tests involving small groups or individual pairs of variables or their categories. Further, no evidence was found of causal relationships. These deficiencies can be resolved or significantly alleviated by developing statistical models that simultaneously involve many exogenous and endogenous variables. This was done by determining effect paths and direct and indirect effects; for example, in the SEM (with proper adjustments for all involved variables).

Chapter 5 will focus on the development, justification, description and interpretation of such models for the available survey data sample. Additionally, discussions and comparisons of this study findings will be made with the previous literature information and findings, thus eliminating the need for a separate discussion chapter.

Chapter 5: Results and Discussion of Quantitative Data

5.1 Introduction

Chapter 4 discussed the descriptive analysis of the preliminary summary statistics analysis of the questionnaire data and outlined the composition of the participating cohort and an understanding of potential significant relationships between the variables. This chapter presents and discusses the major quantitative outcomes of the statistical modelling of the survey data, including the description and interpretation of the major identified statistical constructs associated with risk management in the construction projects in the UAE. The first analytical step will be to develop, validate and discuss the constructs (factors) associated with risk management and successful completion of construction projects. The second step will be to develop SEM and GSEM models involving the developed constructs and other company and demographic variables. The third step will be the discussion and quantitative characterisation of any direct and indirect effects between the involved variables and constructs. This step will also include interpretations of the obtained outcomes and causal relationships between the constructs and variables involved, identification of the most important and significant risks associated with the development of construction projects in the UAE context, and comparisons with the previous literature findings.

5.2 Construct Development

5.2.1 Dependent Constructs

As outlined in Chapter 3, the development and discussions of the quantitative analysis and modelling commenced with the determination and characterisation of the statistical constructs (also termed as factors or latent variables) derived based on the survey items (Appendix 4). The survey items representing the dependent variables and/or constructs were those that reflected participants' perceptions about the success of the construction projects and/or the success of the company in identifying, managing and assessing risks. Contextually, these items included Q25.2–Q25.5, Q34.1, Q34.2, Q35 and Q38, Q39 and Q40 (Appendix 4). Based on these survey items, the following two different constructs (factors or latent variables) were proposed:

1. *Risk Management (RM) Practice Outcomes:* This proposed factor was constructed based on items Q25.2–Q25.5, Q34.1 and Q34.2 (Appendix 4). Contextually, these

survey items were related to how successful the company was in terms of identifying, managing and assessing risks, including through the implementation of risk management procedures; and

2. *Project Success*: This proposed factor was constructed based on items Q35 and Q38–Q40 (Appendix 4) to reflect the success or otherwise in completing construction projects undertaken within the previous two years.

Following this intuitive association of the survey items with the two constructs, further analysis and modelling focused on the validation and mathematical justification (confirmation or rejection) of these constructs and their item associations.

Specifically, exploratory factor analysis (EFA) and Cronbach's alpha were used to confirm that the associations of the indicated survey items with the two constructs were mathematically justified and internally consistent with the respective constructs. Table 5.1 presents the factor loadings resulting from the application of EFA to the five items in Question 25 of the survey (Appendix 4).

Table 5.1: EFA Factor Loadings for Q25

Variable	Factor 1	Factor 2
Q25.1	–0.20	0.79
Q25.2	0.68	0.027
Q25.3	0.68	−0.14
Q25.4	0.64	−0.046
Q25.5	0.38	0.69

The application of EFA to items Q25.1–Q25.5 demonstrates that this set of items can be sub-divided into two different factors satisfying the Kaiser criterion (Section 3.5.1.1). The factor loadings (pattern matrix) for these two factors are shown in Table 5.1. For Factor 1, item Q25.1 has a loading that is below the conventional cut-off of 0.3 (Gorsuch, 1983; Stevens, 2012). Therefore, this item is not considered in Factor 1.

The other four items are dully associated with this factor and correspond to the intuitively assumed construct of RM practice outcomes. Factor 2 is not relevant because it contains only two variables, one of which (item Q25.1) could be intuitively associated with the RM practices construct (Section 5.2.2.1). However, Q25.1 appears to be inconsistent and/or insignificant for the RM practices construct; thus, this item is not considered in the analysis and modelling.

Table 5.2: EFA Factor Loadings for RM Practice Outcomes Construct

Variable	RM practice outcomes
Q25.2	0.55
Q25.3	0.61
Q25.4	0.60
Q25.5	0.40
Q34.1	−0.60
Q34.2	−0.62

Items Q34.1 and Q34.2 can also be regarded as directly relevant to the RM practice outcomes construct because they are similar to Q25.2–Q25.5 (Appendix 4). Therefore, it is reasonable to expect that Q34.1 and Q34.2 should also be included in the RM practice outcomes construct. Indeed, EFA applied to all of these items confirms this perception, with the respective factor loadings shown in Table 5.2. The negative signs of the factor loadings corresponding to Q34.1 and Q34.2 (Table 5.2) are expected because the direction of items Q34.1 and Q34.2 opposes the direction of items Q25.2–Q25.5.

EFA confirmed our intuitive expectation that the items shown in Table 5.2 were associated with the RM practice outcomes factor. To further validate this conclusion, Cronbach's alpha analysis was used, which is useful for testing the internal consistency of a factor (Cronbach, 1951; Nunnally, 1978; Stegmann, 2017; Wolf *et al*., 2013). As described in Section 3.5.1.2, Cronbach's alpha analysis was conducted in two different ways. First, the overall Cronbach's alpha was calculated for all six items in the RM practice outcomes factor. Second, Cronbach's alpha was calculated for each possible set of five items chosen out of the six items associated with the RM practice outcomes factor (Table 5.2). As Cronbach's alpha tends to increase with an increasing number of items in a factor (Almehrizi, 2013; Cortina, 1993; Tavakol & Dennick, 2011), reducing the number of items by one (from six to five in this case) should result in decreasing the value of Cronbach's alpha. If this does not happen, the removed item is internally inconsistent with the factor (Almehrizi, 2013; Cortina, 1993; Tavakol & Dennick, 2011). Table 5.3 presents the outcomes of the Cronbach's alpha analysis.

The overall value of Cronbach's alpha for all six items associated with the factor was around 0.536, which corresponds to relatively low but still acceptable internal consistency of the factor (George & Mallery, 2003; Stegmann, 2017). Removal of any of the six items, except for item Q25.5, results in decreasing the value of Cronbach's alpha (Table 5.3), which is expected for an internally consistent factor (Almehrizi, 2013; Cortina, 1993; Tavakol & Dennick, 2011). Further, the removal of item Q25.5 results in a small increase in Cronbach's alpha compared with its overall value (Table 5.3). This is an indication that Q25.5 is at the borderline of internal consistency with the RM practice outcomes factor. This is consistent with the previous observation that item Q25.5 had the lowest factor loading (see Table 5.2).

Table 5.3: Cronbach's Alphas for RM Practice Outcomes

Removed item	**Cronbach's alpha**
Q25.2	0.478
Q25.3	0.470
Q25.4	0.480
Q25.5	0.542
Q34.1	0.481
Q34.2	0.491
For all 6 items	0.536

As indicated above, although the Cronbach's alpha of 0.536 for all six items in the RM practice outcomes construct could suggest acceptable internal consistency of the factor, it is still quite low for such a suggestion to be conclusive (George & Mallery, 2003; Stegmann, 2017). In addition to this, questions might remain about the consistency of item Q25.5 (Table 5.3). As a result, the application of CFA is essential to confirm and further characterise the RM practice outcomes construct.

Figure 5.1 presents the CFA outcomes for the RM practice outcomes construct and quantifies the relationships between this construct and the associated measurable variables (survey items). This construct was designed as a measure of the overall difficulties and problems experienced by the company in identifying and managing risks. This is the reason why items Q25.2–Q25.5 (measuring difficulties and problems in risk management, see Appendix 4) have positive factor loadings in the CFA model (Figure 5.1) and items Q34.1 and Q34.2 (measuring successful risk management) have negative factor loadings.

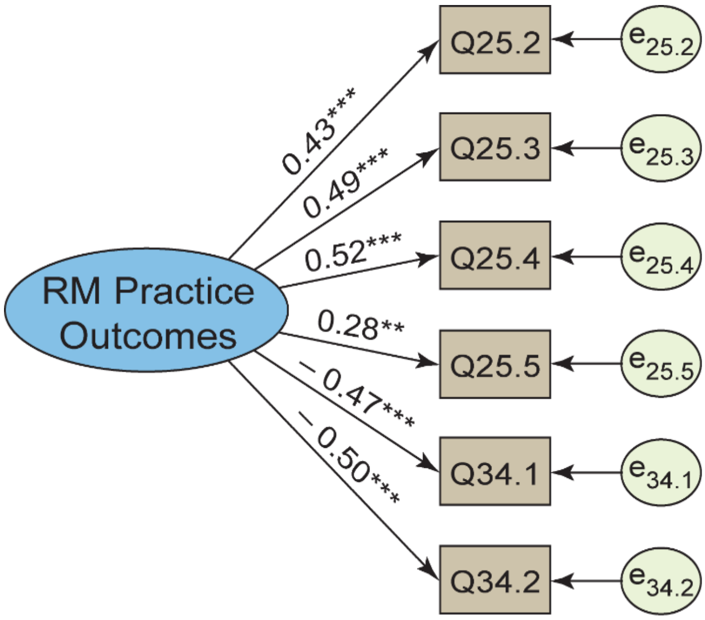


Figure 5.1: RM Practice Outcomes CFA Model

Figure 5.1 shows the standardised CFA model for the RM practice outcomes construct (factor or latent variable), which was constructed based on items Q25.2–Q25.5 and Q34.1–Q34.2 (Appendix 4). The standardised factor loadings (regression coefficients) are shown next to the arrows from the RM practice outcomes factor to the corresponding survey items (measurable variables). Asterisks show the levels of statistical significance of the corresponding factor loadings: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$. No covariances between any of the items were needed for this construct.

The comparison of the magnitudes of the factor loadings shows the relative strength of association of the variables with the factor (i.e., the importance of the variables for the factor). All items in Figure 5.1 except for Q25.5 have approximately the same (or quite similar) magnitudes of factor loadings. This is an indication of their approximately equal importance for the RM practice outcomes construct. As explained above, RM practice outcomes measured the degree of difficulties or problems the company experienced in identifying and managing risks. This characteristic is in appropriate consistency/agreement with items Q25.2–Q25.4 and Q34.1–Q34.2 in evaluating companies' difficulties in identifying 'the main risks' (Q25.2); 'the likelihood of risks occurring' (Q25.3), assessing 'the effects of risks' (Q25.4) and evaluating companies' abilities to 'support effective risk management' (Q34.1–Q34.2). As a result, Figure 5.1 shows approximately equal factor loadings for all of these items.

In contrast, item Q25.5 ('The company relies on external advice to assess risk') has a notably smaller factor loading of 0.28 (Figure 5.1), which is an indication of its lesser importance for RM practice outcomes. This is because this item might have been perceived by the participants as somewhat different from the described major characteristic of RM practice outcomes. Therefore, item Q25.5 has the lowest contribution to the factor score (calculated from the CFA model) for RM practice outcomes (latent variable) used in the subsequent GSEM modelling.

This outcome for item Q25.5 is consistent with the previous observations of its borderline consistency with the RM practice outcomes construct (Table 5.3) and relatively small EFA factor loading (Table 5.2). Nonetheless, it was decided to retain this item in the construct of RM practice outcomes because the developed CFA model suggested its significance (Figure 5.1).

Table 5.4: Cronbach's Alpha Values for Project Success

Removed item	Cronbach's alpha
Q35	0.861
Q38	0.803
Q39	0.801
Q40	0.809
For all 4 items	0.858

The described analytical procedure was also used for the determination, justification and consideration of the other constructs derived in this study (Section 5.2.2). For example, EFA was applied to items Q35 and Q38–Q40 to confirm that they formed another dependent construct termed as project success. Table 5.4 presents the outcomes of the Cronbach's alpha analysis for this construct. As shown, the values of Cronbach's alpha for this construct correspond to excellent internal consistency (George & Mallery, 2003; Stegmann, 2017). Removal of item Q35 from the construct results in a slight increase in Cronbach's alpha (Table 5.4). However, this increase was very small and was thus not regarded as sufficient to remove the item from the final version of the project success construct. This decision was further corroborated by the development of the respective CFA model, which demonstrated that item Q35 was highly significant for the project success construct (Figure 5.2).

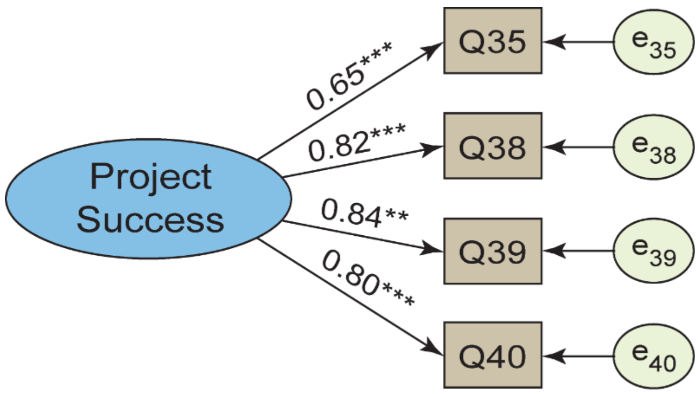


Figure 5.2: Project Success CFA Model

Figure 5.2 shows the standardised CFA model for the project success outcomes construct (factor or latent variable), which was constructed based on items Q35, Q38–Q40. The standardised factor loadings (regression coefficients) are shown next to the arrows from the project success outcomes factor to the corresponding survey items (measurable variables). Asterisks show the levels of statistical significance of the corresponding factor loadings: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$. No covariances between any of the items were needed for this construct.

It is important to note that in this CFA model (Figure 5.2), variables Q35 and Q38–Q40 were considered numerical variables on a scale of 0–3, with 0 corresponding to the answers 'not at all' and 'very low' (Appendix 4), and 3 corresponding to the answers 'mostly' and 'high'. In this way, the developed construct of project success was a measure of the success of the project in the sense that increasing the score of the construct corresponded to better implementation of the project (i.e., greater success).

Consideration of the factor loadings for the developed CFA model again enables a quantitative comparison of the association of the items with the project success factor. As shown, items Q38–Q40 have approximately the same associations with the factor (Figure 5.2), whereas item Q35 is characterised by a lower factor loading, which indicates its lower association with the project success factor.

There is no clear reason why item Q35 would have a lower factor loading because it is similar in nature to item Q39, which has the largest factor loading (Figure 5.2). It could be argued that the lower factor loading for item Q35 might be related to perception ambiguities in relation to the more general term 'project's objectives', as opposed to 'project's quality objectives' (as in Q39). Interestingly, the fact that Q35 has a lower factor loading (Figure 5.2) is again consistent with its borderline internal consistency with the project success factor (Table 5.4). This reinforces the suggestion about perception ambiguities in relation to the general term 'project's objectives'.

Table 5.5: Model Fit for CFA Models – Dependent Constructs

GOF	Dependent factors	
	RM practice outcomes	**Project success**
p-value for χ^2	0.57	0.49
RMSEA	< 0.001	< 0.001
CFI	1	1
TLI	1	1
SRMR	0.037	0.010
CD	0.62	0.88

Note:
Goodness of fit (GOF) indices (Appendix 5) for the two dependent factors: RM practice outcomes and project success. RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker–Lewis index; SRMR = standardised root mean square residual; CD = Coefficient of determination.

As explained in Section 3.5.1.3 and Appendix 5, model fits for the developed CFA models for the two dependent constructs of RM practice outcomes and project success (Figures 5.1 and 5.2) were evaluated using GOF indices (Table 5.5). The *p*-values shown in the first row of Table 5.5 represent the quantitative outcomes of the χ-square test and they determine the significance of the developed CFA models. The larger the *p*-values associated with the χ-square test, the better the developed CFA model fits to the data (Appendix 5). As explained in Appendix 5, this is because the *p*-value obtained from the χ-square test is equal to the probability that the developed model is *not significantly different* from the perfect model.

The *p*-values for both factors in Table 5.5 indicate excellent levels of significance of the developed CFA models (Figures 5.1 and 5.2). This is because both *p*-values are much larger than the conventional threshold of 0.05 for significance of the χ-square test (Bustamante & Chacon, 2016; Hair *et al.*, 1995; Mulaik *et al.*, 1989; Schermelleh-Engel *et al.*, 2003). The other GOF indices (Table 5.5) further corroborate the conclusion regarding the excellent fit for both CFA models.

The values of the coefficient of determination (CD) in Table 5.5 show that around 62% of the total variable of the associated items can be explained by the construct of RM practice outcomes and approximately 88% by the project success construct. Therefore, an explanation of only around 38% and 12% of the total variance of the items associated with the constructs of RM practice outcomes and project success, respectively, requires some other variables or factors that have not been considered in the current CFA models shown in Figures 5.1 and 5.2. This is a reasonable outcome that demonstrates the high relevance of the developed models to the consideration and characterisation of the associated items.

5.2.2 Independent Constructs

The independent constructs in this study were developed to reflect the risk management practices adopted by the participating companies, internal and external risks to the success of construction projects, and a variety of economic and cultural factors specific to the UAE construction industry. The following independent constructs were created based on the survey instrument (Appendix 4):

1. *Risk Management (RM) Practices*: items Q20–Q22. These items were associated with the perceptions of the study participants about the existence of efficient practices and strategies associated with risk management in their companies;
2. *External Risks*: Q29.1, Q29.2, Q29.12 and Q29.13. This construct reflects significant external matters and difficulties that are largely beyond companies' control (e.g., corruption, law changes, market demands, cultural differences) but that may affect the success of construction projects;
3. *Internal Risks*: Q29.4, Q29.11, Q29.14 and Q29.15. This construct addresses difficulties (risks) associated with internal company issues that companies have control over;
4. *Financial Risks*: Q29.5–Q29.8, Q29.10 and Q30.11. This construct specifically addresses any existing financial, inflationary and currency difficulties (risks) for the project that could be within or beyond companies' control;
5. *Contract Importance*: Q30.1–Q30.6 and Q30.13. This construct measures the extent to which contractual issues and contract preparation affect and are perceived as important for the success of construction projects, including proper choice of contractors, financial, operational and managerial planning;
6. *Resources and Technology (R&T) Importance*: Q30.7, Q30.8, Q30.10 and Q30.12. This construct measures the extent to which R&T issues are important for (or affected by) the success of construction projects, including the use of efficient technology and

equipment and efficient procurement of resources and materials;

7. *UAE Culture*: Q31.1–Q31.5. This construct determines and evaluates the effect of general cultural matters in the UAE on successful company performance and the completion of construction projects;

8. *Cultural Diversity*: Q31.14–Q31.17 and Q31.19. This construct addresses issues and risks associated with the diversity of cultural backgrounds, languages and education in the workforce at UAE construction companies; and

9. *Communication*: Q31.6–Q31.10, Q31.18, Q34.3 and Q34.9. This construct measures the level and efficiency of communication and interaction between employees at UAE construction companies, as well as with consultants, clients and between different levels of management and stakeholders.

Other items were originally considered for some of the listed constructs (e.g., Q29.3 for external risks, Q29.9 for internal risks and external risks, Q30.9 and Q30.11 for R&T and Q30.4 for contract preparation). However, these items were not included in the constructs because of their lack of statistical significance or internal consistency with the respective construct. For example, item Q29.9 appeared to reflect an important aspect of low productivity in the UAE construction industry, which could be caused by low labour productivity and obsolete technology and practices. However, this item was not statistically significant in the external and internal risks constructs; thus, it was excluded from the respective CFA models.

5.2.2.1 RM Practices

Figure 5.3 presents the outcomes of the CFA modelling of the RM practices construct. As explained in Section 5.2.2, this factor characterised participants' perceived level of existence of efficient practices and strategies associated with risk management.

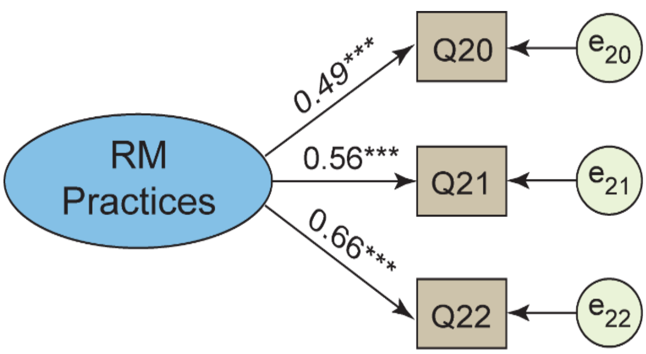


Figure 5.3: RM Practices CFA Model

The figure shows the standardised CFA model for the independent RM practices factor, which was constructed based on items Q20–Q22 (Appendix 4). Factor loadings are shown next to the arrows from the RM practices factor to the corresponding items (measurable variables). Asterisks show the level of statistical significance for the corresponding factor loadings: (***) $p < 0.001$. No covariances between any of the items were needed for this construct.

In particular, the item of greatest importance for this construct is Q22 ('Are you satisfied with the prevailing risk management strategy of your company?'), which has the largest factor loading of 0.66. This is expected because this item appears to be the most relevant to participants' perceptions of the existence of effective practices and strategies in their company. The other two items associated with the RM practices construct (Figure 5.3 and Appendix 4) might be considered less specific and less precise in determining the efficiency of existing risk management strategies. This is expectedly reflected in their lower factor loadings.

Although item Q20 ('In your organisation, is there interaction between expert risk management team and other professional employees?') is relevant to existing management practices (e.g., through the indicated interaction), it could also be perceived as partly relevant to communication and it is arguably the least relevant of the three items (Figure 5.3) to the determination of RM practices and their efficiency. This is the reason for its lowest factor loading in Figure 5.3 and, thus, the lowest importance for the RM practices factor score (see Section 3.5.1.3 for the methods used to calculate factor scores).

The GOF indices for the developed CFA model for the RM practices factor (Figure 5.3) are shown in Table 5.6. The table illustrates that the obtained model fit for this factor is excellent, including the exceptionally large p-value for the model χ-square test (as expected for an excellent model fit; Appendix 5). The other GOF indices (Table 5.6) further confirm the excellent model fit for the CFA model for the RM practices factor (Figure 5.3). The CD value of 0.61 demonstrates that the developed model accounts for around 61% of the total variance of the items associated with the RM practices factor. This means that only about 39% of the total variance requires consideration of variables or factors that are not associated with the RM practices factor (Figure 5.3). This is a reasonable outcome that demonstrates the capability of the developed RM practices factor to describe the associated items and their variance.

Table 5.6: Model Fit for CFA Models – Independent Constructs

GOF	**Independent factors**								
	RM practices	**External risks**	**Internal risks**	**Financial risks**	**Contract importance**	**R&T importance**	**UAE culture**	**Cultural diversity**	**Communication**
p-value for χ^2	> 0.99	0.50	0.13	0.63	0.35	0.34	0.17	0.92	0.12
RMSEA	< 0.001	< 0.001	0.065	< 0.001	0.022	< 0.001	0.048	< 0.001	0.041
CFI	1	1	0.98	1	0.99	1	0.92	1	0.93
TLI	1	1	0.95	1	0.99	1	0.84	1	0.89
SRMR	< 0.001	0.025	0.032	0.045	0.105	0.025	0.064	0.022	0.106
CD	0.61	0.69	0.81	0.73	0.85	0.88	0.67	0.62	0.76
Cronbach's alpha	0.57	0.63	0.77	0.71	0.77	0.72	0.61	0.58	0.66

Note:
GOF indices for the nine independent factors used in the statistical modelling (Appendix 5).

The value of Cronbach's alpha (0.57; Table 5.6) for the RM practices factor is on the lower side. This could indicate some issues with the internal consistency of this factor. Further, lower values of Cronbach's alpha are typically obtained for constructs associated with fewer measurable variables (Almehrizi, 2013; Cortina, 1993; Tavakol & Dennick, 2011). This is likely to be one of the reasons for the relatively low value of Cronbach's alpha for the RM practices factor associated with only three measurable variables. It is also necessary to keep in mind that Cronbach's alpha analysis is an exploratory approach that usually only gives indications of factor validity. The final decision about a factor should be made based on CFA, which demonstrates excellent significance of all three items associated with the RM practices factor (Figure 5.3), as well as excellent values of GOF indices (Table 5.6).

5.2.2.2 External Risks

The second independent construct was the external risks construct (Figure 5.4). This factor characterised external (to the company) matters and difficulties existing in the broader context and society. The external risks, such as corruption, law changes, market demands and cultural differences, are beyond companies' control, but they have significant potential to affect companies' operations and capability to complete construction projects on schedule and on budget.

The items of the greatest importance for the external risks construct are Q29.1 ('Corrupt government officials demand bribes or unjust rewards') and Q29.12 ('Inadequate forecast about market demand'), which have the largest factor loading of 0.65 and 0.70, respectively. The two items have arguably the largest association with the external risks construct, which means that they could be regarded as the items presenting the largest external risks for UAE construction projects.

In contrast, Q29.13 ('Differences in work culture, education and values between project stakeholders') could be regarded (was perceived) as the least important external risk for UAE construction projects. However, this does not mean that cultural differences do not present any risks for the UAE construction industry. Rather, the high significance of Q29.13 in the developed model (Figure 5.4) highlights the importance of the issue, although to a lower extent compared with corruption and variable market demands.

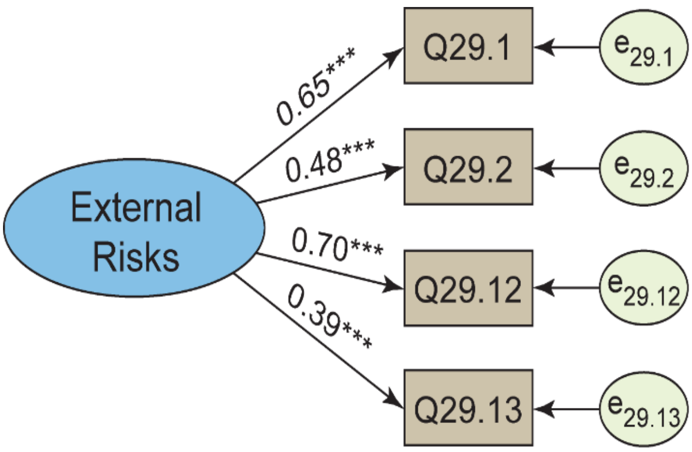


Figure 5.4: External Risks CFA Model

Figure 5.4 presents the standardised CFA model for the independent external risks factor, which was constructed based on items Q29.1, Q29.2, Q29.12 and Q29.13. Factor loadings are shown next to the arrows from the external risks factor to the associated items (measurable variables). Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. No covariances between any of the items were necessary in this construct.

These are important findings because they could show the most efficient ways for alleviating external risks; for example, by addressing, as a matter of priority, the most important risks associated with corruption and variable market demands. However, it is also important to note that addressing these risks is largely beyond the capabilities or control of each construction company. Therefore, this would be a task mostly for the government, law enforcement agencies and/or appropriate organisations (for example, forecasting and evaluating market demands). This conclusion is regarded as one of the recommendations flowing from this study.

GOF indices determining the fit of the developed CFA model for the external risks construct (Figure 5.4) are shown in Table 5.6. As shown, the model fit for this factor is excellent, which is confirmed by all GOF indices (Table 5.6). The CD value of 0.69 demonstrates that the developed model accounts for around 69% of the total variance of the four items associated with the external risks factor. This means that only around 31% of the total variance of the four items required consideration of variables or factors other than the external risks factor.

The value of Cronbach's alpha for the external risks factor (0.63; Table 5.6) is larger than for the RM practices factor (0.57; Table 5.6). However, it is still on the lower side. As mentioned in Section 5.2.2.1 for the RM practices factor, the Cronbach's alpha analysis is an exploratory approach that usually only gives indications of factor validity. Further, the CFA model demonstrates excellent significance of all four items associated with the external risks factor (Figure 5.4). Additionally, this model is characterised by excellent values of GOF indices (Table 5.6), which justifies the inclusion of all four items in the external risks factor (Figure 5.4).

Nonetheless, it is important to note that the detailed Cronbach's alpha analysis shows borderline internal consistency of Q29.13 with the external risks factor. This is because the value of Cronbach's alpha marginally increased from 0.6257 to 0.6277 upon removing Q29.13 from the external risks factor. Although this finding is not the reason for removing this highly significant item from the factor, it is consistent with the fact that Q29.13 is characterised by the lowest factor loading (Figure 5.4).

Therefore, it can be concluded that, although cultural differences are a significant external risk, they are also perceived to affect construction projects not only as an *external* risk (similar to corruption and variable market demands) but also as a separate risk associated with internal cultural diversity in the company (Section 5.2.2.3). This is likely to cause the borderline internal consistency of Q29.13 with the external risks construct, as highlighted by the described outcomes of the Cronbach's alpha analysis.

5.2.2.3 Internal Risks

The third independent construct was the internal risks factor (Figure 5.5). This factor grouped internal (to the company) matters and difficulties associated with project design and management, production site and available human resources. These internal matters are within companies' control, which was the reason for grouping the associated items into the internal risks construct and thus distinguishing this construct from the external risks factor (described in Section 5.2.2.2). Internal risks can significantly affect a company's ability to successfully implement a construction project, which constitutes a construction risk.

There are two items of similar importance in the internal risks construct: Q29.4 ('High rate of accidents during construction or operation phases') and Q29.15 ('Unanticipated design changes and errors in design/drawings'). The two items had the largest factor loadings of 0.79 and 0.72, respectively. Therefore, they had the strongest association with the internal risks construct, which means they can be regarded as the greatest internal risks for UAE construction projects. Q29.14 ('Facing difficulties in hiring and retaining valued and valuable employees') also had a very similar, although somewhat lower, factor loading of 0.69 (Figure 5.5), which shows that this item also represents an important internal risk.

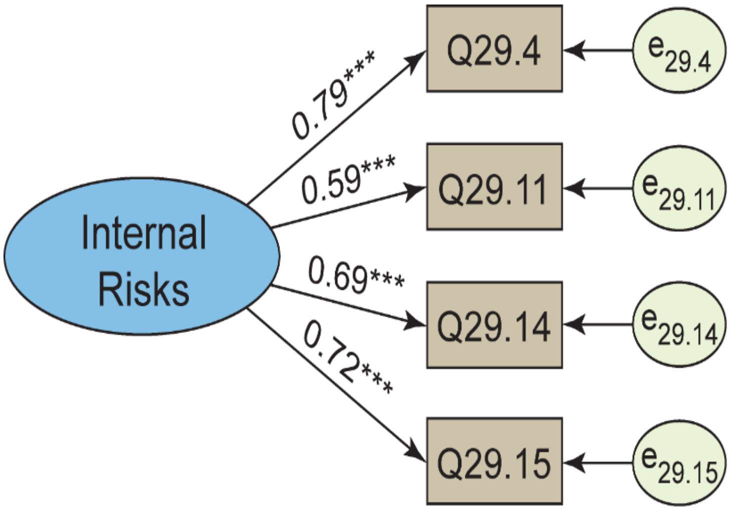


Figure 5.5: Internal Risks CFA Model

The standardised CFA model for the independent internal risks factor was constructed on the basis of the indicated items. The factor loadings are shown next to the arrows from the internal risks factor to the associated items (measurable variables). Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. No covariances between any of the items were necessary for this construct.

In contrast, Q29.11 (‘Inadequate project planning, budgeting, inadequate organisational structure or a lack of competency in the local project team’) was perceived as the least important (although no less statistically significant; Figure 5.5) internal risk for UAE construction projects. This perception could have been partly caused by the significant generality of Q29.11 including a range of issues such as project planning, budgeting, organisational structure and project team. This generality might have caused a broader variety of perceptions and responses, resulting in somewhat lower relevance of Q29.11 to the internal risks construct.

Moreover, the most likely reason for the lower relevance of Q29.11 to the internal risks construct (particularly considering the high level of significance of this item; Figure 5.5) may be related to the nature of the matters included in this item. Therefore, the matters raised by Q29.11 are probably less important internal risks for construction projects under UAE conditions compared with the matters raised by the other three items (Figure 5.5).

These findings lead to specific recommendations, particularly for the construction companies rather than governing and evaluating authorities and organisations. For example, according to the factor analysis (Figure 5.5), the primary efforts of the constructing companies in managing and reducing internal risks should focus on site safety, design changes and errors and retaining a qualified workforce. Other issues associated with project planning, budgeting, organisational structure and project team are less important.

GOF indices determining the fit of the developed CFA model for the internal risks construct (Figure 5.5) are shown in Table 5.6. The model fit for this factor was 'good'. The CD value of 0.81 demonstrates that the developed model accounts for around 81% of the total variance of the four items associated with the internal risks factor. This means that only around 19% of the total variance of these items required consideration of variables or factors other than the internal risks factor (Figure 5.5).

The value of Cronbach's alpha for the internal risks factor (0.77; Table 5.6) shows good internal consistency of this factor. The final CFA model confirms this by demonstrating excellent levels of significance for all four items associated with the internal risks factor (Figure 5.5).

5.2.2.4 Financial Risks

The fourth independent construct was the financial risks factor (Figure 5.6). This factor grouped the items relevant to cash flow, exchange rate, inflation, client payments and cost overruns. These financial matters are partly within companies' control (e.g., cash flow and budget management) and partly beyond their control (e.g., foreign exchange and inflation). Nonetheless, all items associated with the financial risks factor are highly significant (Figure 5.6) and have approximately equal factor loadings.

The fact that all items in the financial risks factor have approximately the same factor loadings (Figure 5.6) suggests that all six associated items are of approximately equal importance (relevance) to the factor. The lowest factor loading of 0.49 belongs to Q29.5 ('Foreign exchange liquidity, financial soundness'), which suggests lower importance of the matters covered by this item for the factor. One reason for the somewhat lower factor loading for Q29.5 may be related to the more general and, possibly, more vague formulation of this item. This may have caused a broader variety of perceptions and responses, resulting in somewhat lower relevance of Q29.5 to the financial risks construct.

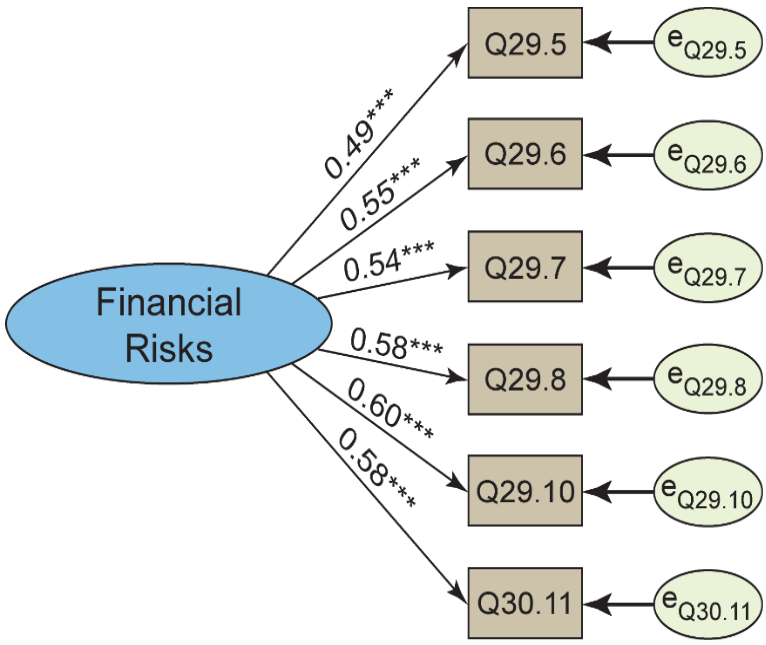


Figure 5.6: Financial Risks CFA Model

Figure 5.6 shows the standardised CFA model for the independent financial risks factor, which was constructed based on the indicated items. Factor loadings are shown next to the arrows from the financial risks factor to the associated items (measurable variables). Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. No covariances between any of the items were necessary for this construct.

As all six items in the financial risks factor are of similar importance for the factor, a practical recommendation to construction companies attempting to reduce financial risks is to concentrate on all risks that are within their control. This includes improvements to cash flow, better relationships and agreements with clients to ensure their payments are on schedule, better financial operations and management (reducing cost overruns) and more reliable internal forecasting of and planning for inflation and exchange rates.

GOF indices determining the fit of the developed CFA model for the financial risks construct (Figure 5.6) are shown in Table 5.6. As shown, the model fit for this factor is 'excellent'. The CD value of 0.73 demonstrates that the developed model accounts for around 73% of the total variance of the items associated with the financial risks factor. This means that only around 27% of the total variance of the items required consideration of variables or factors other than the financial risks construct (Figure 5.6).

The value of Cronbach's alpha (0.71; Table 5.6) for the financial risks factor shows good internal consistency of this factor. The final CFA model confirms this by demonstrating excellent significance of all six items associated with the financial risks factor (Figure 5.6).

5.2.2.5 Contract Importance

The fifth independent construct was the contract importance factor (Figure 5.7). This factor grouped the items relevant to the preparation of the contract associated with the construction project, including evaluation of potential contractors, budget allocations, pricing bills of quantities, contractual terms and conditions, reputable consultants, work plans and estimations of schedule. These matters are typically within companies' control; thus, they are particularly important for the development of efficient company strategies for risk management.

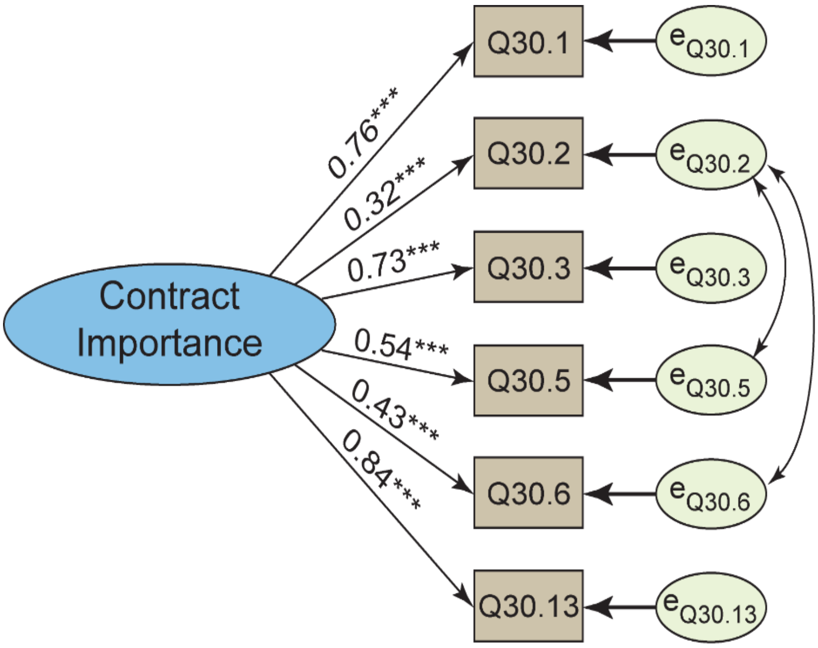


Figure 5.7: Contract Importance CFA Model

Figure 5.7 shows the standardised CFA model for the independent contract importance factor, which was constructed based on the indicated items. The factor loadings are shown next to the arrows from the contract importance factor to the associated items (measurable variables). Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. The connecting arrows show the significant covariances between the respective items.

Not all items associated with the contract importance factor have the same factor loadings. For example, Q30.1 ('Examining the financial resources liability/employer's financial viability'), Q30.3 ('Measuring and pricing bills of quantities properly during the bidding phase') and Q30.13 ('Good forecasting of work plan/estimating project duration') have the largest factor loadings of 0.76, 0.73 and 0.84 respectively (Figure 5.7). This demonstrates the particular relevance of these items for the contract importance factor.

In contrast, Q30.2 (‘Reviewing the contract properly to allocate extra budget in the bidding stage’) and Q30.6 (‘Employing reputable third-party consultants to forecast market demand’) are the least important for the contract importance factor because they have the lowest factor loadings of 0.31 and 0.43, respectively (Figure 5.7).

It is interesting to observe that although the evaluation and forecast of market demand (e.g., by employing third-party consultants) is one of the least important contract importance risks (Figure 5.7), it was simultaneously identified as the most important external risk (Figure 5.4). This is not a contradiction because Figure 5.4 considers external risks that were beyond companies’ control, while Figure 5.7 deals with contractual risks that are within their control.

Therefore, variability of market demand and its proper forecast was perceived as one of the major external risks that should be addressed by the external (government) bodies and organisations responsible for such forecasts. Further, it is regarded as less important for a construction company to employ consultants to make such forecasts. That is, the forecasting of variability of market demand is not regarded as a priority for companies, but it is regarded as a matter of priority for the government or other external bodies providing information about variability and forecasting of market demand.

Recommendations to UAE construction companies based on the CFA model of the contract importance factor (Figure 5.7) can therefore be formulated as follows:

- To manage and reduce contractual risks, they should concentrate on evaluating employers’ and contractors’ financial viability and liabilities, pricing bills of quantities during the bidding stage and better planning of work and estimating of project duration; and
- Allocating extra budget for the bidding stage and employing consultants to forecast market demand are less important in terms of effectively reducing contractual risks.

GOF indices determining the fit of the developed CFA model for the contract importance construct (Figure 5.7) are presented in Table 5.6. The model fit for this factor is ‘excellent’ with the CD value of 0.85. This demonstrates that the developed model accounts for around 85% of the total variance of the six items associated with the contract importance factor. This means that only around 15% of the total variance of the items required consideration of variables or factors other than the contract importance factor (Figure 5.7).

The value of Cronbach's alpha (0.77; Table 5.6) for the contract importance factor shows 'good' internal consistency of this factor. The final CFA model confirms this by demonstrating significance of all six items associated with the contract importance factor (Figure 5.7).

5.2.2.6 Resources and Technology (R&T) Importance

Figure 5.8 shows the CFA model for the independent construct of R&T importance. This factor was designed to group the items relevant to the use and/or acquisition of resources and relevant technologies for the construction project.

In the first instance, six items Q30.7–Q30.12 (Appendix 4) were intuitively expected to be in this factor. However, Q30.9 was at the borderline of internal consistency with the factor and (more importantly) was statistically insignificant in the CFA model for the R&T importance factor (with $p > 0.2$). Therefore, item Q30.9 was removed from the R&T importance factor.

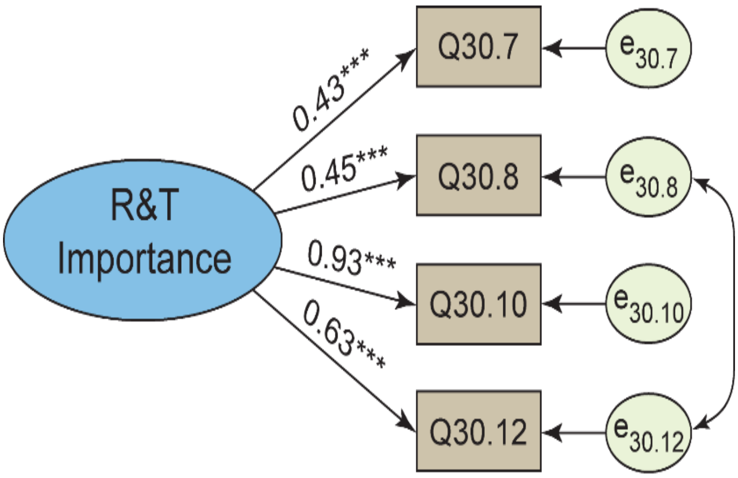


Figure 5.8: R&T Importance CFA Model

Figure 5.8 shows the standardised CFA model for the independent R&T importance factor, which was constructed based on the four items. Factor loadings are shown next to the arrows from the R&T importance factor to the associated items (measurable variables). Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. The connecting arrows show the significant covariance between the respective items.

Item Q30.11 is internally consistent with the R&T importance factor and highly significant in the CFA model (with $p < 0.001$). However, it is also consistent and statistically significant (with $p < 0.001$) in the financial risks factor (Figure 5.6). Including the same item in two different independent constructs is unreasonable and inappropriate because it would introduce artificial relationships between the two factors containing the same item. This would have been effectively related to an effect of the item on itself (which makes no reasonable meaning in the context of the analysis and modelling).

Therefore, it was decided to retain item Q30.11 in the financial risks factor (Figure 5.6) and to remove it from the R&T importance factor (Figure 5.8). This decision was based on the following two considerations:

1. Although the significance levels of Q30.11 were the same for both factors ($p < 0.001$), its factor loading in the financial risks factor was notably larger (0.58 compared with 0.45 in the R&T importance factor), which demonstrated its larger relevance to financial risks; and
2. Careful plain reading of Q30.11 gives the perception that this item is more relevant to the financial risks associated with Q29.6–Q29.8 rather than to R&T.

As a result of these amendments to the R&T importance factor, Q30.7 was at the borderline of internal consistency with the remaining factor. However, this is not regarded as a sufficient reason for its removal because of its high significance in the CFA model (Figure 5.8).

Q30.10 (‘Good financial accountability and management’) may also be relevant to financial risks. However, this is not considered the case because this item is presented in the survey in the context of R&T, which makes it significantly relevant to ‘financial accountability and management’ in relation to R&T for the construction project. That is, the item is perceived as relevant to the management of R&T rather than to financial risks. A significant confirmation for this conclusion is the largest factor loading of 0.93 for Q30.10 in the CFA model for the R&T importance factor (Figure 5.8). Therefore, this item is of great relevance to the R&T importance factor.

In contrast, Q30.7 (‘Provision of sufficient resources as and when required’) and Q30.8 (‘Use of efficient project-related technology’) have the lowest factor loadings of 0.43 and 0.45, respectively (Figure 5.8), which makes them the least relevant to the R&T importance factor. This may be because of the less specific formulation of Q30.7 and the lesser relevance of Q30.8 to the major idea of this construct associated with the effective management of supply of the required materials and equipment.

A relevant recommendation to UAE construction companies based on the CFA model of the R&T importance factor (Figure 5.8) is to focus on the most important risks associated with management and financial accountability in relation to the efficient supply of the required materials and equipment. Although statistically significant, the use of efficient project-related technologies is not perceived as a priority in relation to R&T risks.

GOF indices determining the fit of the developed CFA model for the R&T importance construct (Figure 5.8) are shown in Table 5.6. As shown, the model fit for this factor is ‘excellent’. The CD value of 0.88 demonstrates that the developed model accounts for around 88% of the total variance of the items associated with the R&T importance factor. In this case, around 12% of the total variance of the items requires consideration of variables or factors other than the R&T importance construct (Figure 5.8).

The value of Cronbach’s alpha (0.72; Table 5.6) for the R&T importance factor shows ‘good’ overall internal consistency of this factor. The final CFA model further confirms this by demonstrating significance of all four items associated with the R&T importance factor (Figure 5.8).

5.2.2.7 UAE Culture

The independent construct of UAE culture (Figure 5.9) was designed to group the items relevant to the existing cultural characteristics of UAE business and workplace environment, including items Q31.1–Q31.5 (Appendix 4). The different signs of the factor loadings in Figure 5.9 reflect the opposite directions of the respective survey questions, which results in the opposite signs of their respective influences.

Item Q31.1 (‘Emiratis value personal trust as an important ingredient in business transactions’) is of great importance to the UAE culture factor because it has the largest magnitude of the factor loading (0.63; Figure 5.9). Therefore, this cultural matter is the most important for the management of risks associated with construction projects. Q31.2 (‘Emiratis prefer to do business face to face’) is of similar (although somewhat lesser) importance for the UAE culture factor, with a loading of 0.58. Further, Q31.3 (‘Emiratis like to get to know the person they are doing business with before they do business’) and Q31.4 (‘Attitudes to time in many Western countries are much more relaxed than in the UAE’) are the least important (with respective factor loadings of 0.46 and 0.43; Figure 5.9) in relation to cultural risks in the UAE construction industry.

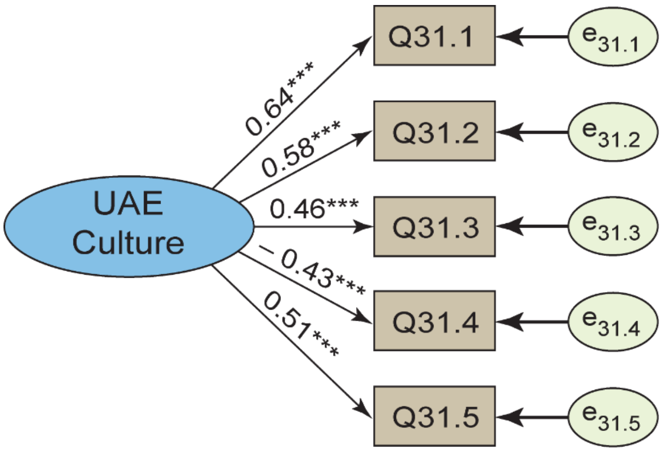


Figure 5.9: UAE Culture CFA Model

Figure 5.9 shows the standardised CFA model for the independent UAE culture factor with the associated items. Factor loadings are shown next to the arrows from the UAE culture factor to the relevant items. Asterisks show the level of statistical significance of the corresponding factor loadings: (***) $p < 0.001$. No covariances between any of the items were needed for this construct.

There is no difference in the direction of the items associated with the UAE culture construct. Therefore, the negative sign of the significant factor loading corresponding to Q31.4 shows that the effect of this item on the UAE culture construct contrasts with the effects of the other four items (Figure 5.9). Therefore, the effect of Q31.4 on project success also contrasted with the effects of the other four items associated with the UAE culture construct (see the models in Section 5.3.2).

The relevant recommendation to UAE construction companies is to give priority to managing and addressing matters of personal trust between project stakeholders and contractors, favouring face-to-face and more personal approaches.

GOF indices determining the fit of the developed CFA model for the UAE culture construct (Figure 5.9) are shown in Table 5.6. As shown, the model fit for this factor is ‘very good’. The CD value of 0.67 demonstrates that the developed model accounts for around 67% of the total variance of the five items associated with the UAE culture factor. This means that only around 33% of the total variance of the items required consideration of variables or factors other than the UAE culture construct (Figure 5.9).

The value of Cronbach’s alpha (0.61; Table 5.6) for the UAE culture factor shows acceptable internal consistency of this factor. The final CFA model demonstrates significance of all five items associated with the UAE culture factor (Figure 5.9).

5.2.2.8 Cultural Diversity

The factor of cultural diversity (Figure 5.10) was constructed to group the items relevant to the existing cultural, educational and language differences within the workforce at UAE construction companies (Q31.14–Q31.17 and Q31.19; Appendix 4).

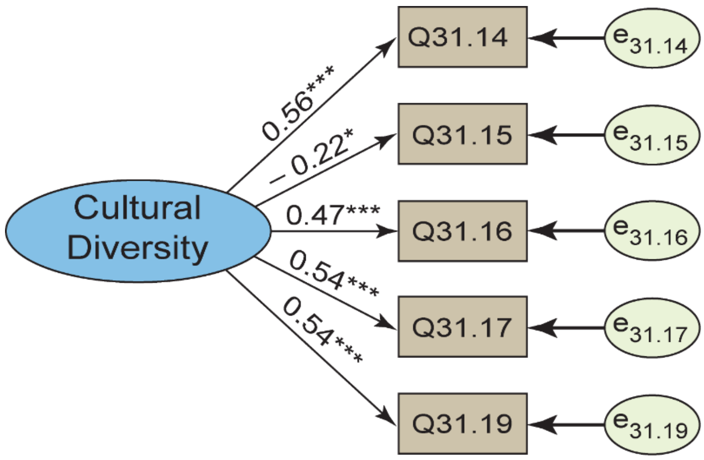


Figure 5.10: Cultural Diversity CFA Model

Figure 5.10 shows the standardised CFA model for the independent cultural diversity factor with the associated items. Factor loadings are shown next to the arrows from the cultural diversity factor to the relevant items. Asterisks show the levels of statistical significance of the corresponding factor loadings: (***) $p < 0.001$; (*) $0.01 \le p < 0.05$. No covariances between any of the items were needed for this construct.

There is no difference in the direction of the items associated with the cultural diversity construct. Therefore, the negative sign of the factor loading corresponding to Q31.15 (Figure 5.10) shows that the effect of this item on the cultural diversity construct contrasts with the effects of the other four items. Therefore, the effect of Q31.15 ('Various educational backgrounds affect the project') on project success also contrasts with the effects of the other four items associated with the cultural diversity construct (see the models in Section 5.3.2.1). For example, if language diversity (Q31.14) affects the project badly, then diversity of educational backgrounds is 'good' for the project and vice versa. Similarly, if the total effect of the cultural diversity latent variable on the project success latent variable is negative, so that increasing cultural diversity results in decreasing project success (Section 5.3.2.1), then increasing the diversity of educational backgrounds must result in increasing project success.

Further, the factor loading for Q31.15 is the smallest in magnitude out of all other items associated with the cultural diversity factor (Figure 5.10). Therefore, Q31.15 has the smallest effect on the cultural diversity factor score and is not a matter of priority from the viewpoint of effective risk management. The most important (and of approximately equal relevance) items for the cultural diversity factor are Q31.14 (‘Various languages affect the project’), Q31.17 (‘Various decision-making processes affect the project’) and Q31.19 (‘Dispute resolution is important in the project’). It is again possible to suggest that Q31.16 (‘Different ways of thinking affect the project’) has somewhat lower factor loadings because of its rather vague and non-specific nature, which allowed diversity of perceptions by the participants.

The relevant recommendation to UAE construction companies is to give priority to managing and overcoming language barriers, diversity of decision-making cultures and development of efficient dispute-resolution procedures and practices.

GOF indices determining the fit of the developed CFA model for the cultural diversity construct (Figure 5.10) are shown in Table 5.6. As shown, the model fit for this factor is ‘very good’. The CD value of 0.62 demonstrates that the developed model accounts for around 62% of the total variance of the five items associated with the cultural diversity factor. This means that only around 38% of the total variance of the items required consideration of variables or factors other than the cultural diversity factor (Figure 5.10). The somewhat lower value of CD for the cultural diversity factor compared with most of the other constructs can be explained by the vast diversity of cultural differences, some of which might not have been fully captured by the respective survey items.

The value of Cronbach’s alpha for the cultural diversity factor (0.58; Table 5.6) shows acceptable internal consistency of this factor. Its relatively low value may once again be explained by the diversity of cultural differences, including a variety of perceptions of these cultural differences and their importance for construction projects. Further, the final CFA model demonstrates the overall significance of the associated items, except for item Q31.15, for which statistical significance (p = 0.040) is somewhat lower than for the other four items (Figure 5.10). This lower significance for Q31.15 is consistent with its borderline internal consistency with the factor (the removal of this item results in a marginal increase of Cronbach’s alpha from 0.5772 to 0.5913). Nonetheless, GOF indices shown in Table 5.6 confirm the validity of the cultural diversity factor by the overall good model fit.

5.2.2.9 Communication

Figure 5.11 shows the CFA model for the communication construct. This factor grouped eight items relevant to the efficiency of risk reporting procedures, communication and interaction between company employees and between the company and contractors, clients and consultants. These matters are largely within companies' control and present significant importance for the development of efficient risk management strategies.

Item Q34.3 ('Reporting and communication process between staff and top management supports the effective management of risk') has the lowest level of statistical significance for the communication factor. In addition to this, it is characterised by the lowest magnitude of the factor loading (Figure 5.11). The other two items with similarly low factor loadings (and thus low relevance to the communication factor) are Q31.9 ('There is a large communication gap between the contractor and the consultant') and Q34.9 ('A functional reporting concept has been designed and fully implemented').

The reasons for these low factor loadings are likely to be different for each of these items. For example, it appears that reporting procedures between staff and top management along with the communication gap between the contractor and the consultant are not perceived as highly important communication risks. Further, the somewhat non-specific nature of 'a functional reporting concept' may be the reason for Q34.9 being interpreted and perceived in diverse ways, which may have caused it to lose relevance to the communication factor and to lose its importance as a communication risk.

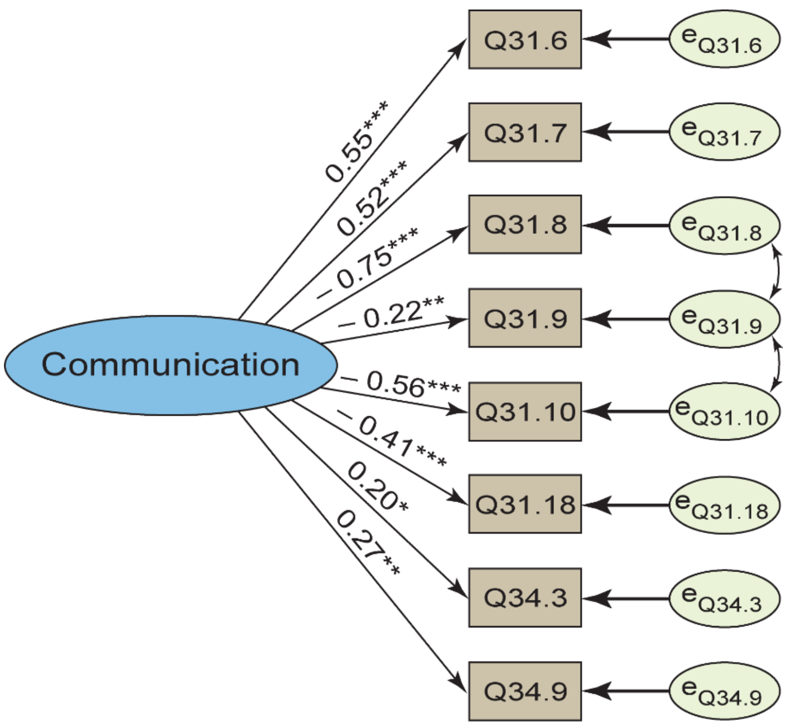


Figure 5.11: Communication CFA Model

Figure 5.11 shows the standardised CFA model for the independent communication factor constructed based on the shown items. The factor loadings are shown next to the arrows from the communication factor to the associated items. Asterisks show the levels of statistical significance of the corresponding factor loadings: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$; (*) $0.01 \leq p < 0.05$. The connecting arrows show the significant covariances between the respective items.

The most important communication risk identified by the CFA modelling (Figure 5.11) is Q31.8 ('There is a large communication gap between the contractor and the client'), which has the largest magnitude of its factor loading. The other three important items are Q31.6 ('The system of communication about the nature of risks within the organisation is effective'), Q31.7 ('The system of communication about risk mitigation strategies within the organisation is effective') and Q31.10 ('There is a large communication gap between the contractor and the employees'). These matters represent significant communication risks for the construction projects.

The negative signs of the factor loadings associated with items Q31.8–Q31.10 (Figure 5.11) show that the communication factor score increases with decreasing communication gaps. Therefore, if the communication factor has a positive effect on project success, then communication gaps (items Q31.8–Q31.10) must have negative effects on project success. Similarly, the negative sign of the factor loading for Q31.18 ('Stakeholder engagement is important in the project') shows that if the communication factor has a positive effect on project success, then stakeholder engagement in the project is not desirable for the success of the project and vice versa.

The main recommendation to construction companies is that, when managing and reducing risks associated with communication is to

- *Prioritise*: Priority should be given to managing and reducing communication gaps between the contractor and the client and between the contractor and employees; and
- *Develop*: Keep developing effective systems of communication in relation to any risks and their mitigation strategies.

Reporting procedures between staff and top management, along with the communication gap between the contractor and the consultant, did not arise as issues of priority in the developed model (Figure 5.11).

GOF indices determining the fit of the developed CFA model for the communication construct (Figure 5.11) are shown in Table 5.6. As shown, the model fit for this factor is ‘good’. The CD value of 0.76 demonstrates that the developed model accounts for around 76% of the total variance of the eight items associated with the communication factor. This means that around 24% of the total variance of the items required consideration of variables or factors other than the developed communication construct (Figure 5.7).

The value of Cronbach’s alpha (0.66; Table 5.6) for the communication factor shows reasonable internal consistency of this factor. The final CFA model demonstrates significance (although at different levels) of all eight items associated with the communication factor (Figure 5.11).

5.3 Generalised Structural Equation Modelling Models

Section 5.2 introduced and justified two dependent constructs and nine independent constructs associated with the analysed data and the research objectives of the project. As there was a significant possibility that the developed independent constructs would affect not only the dependent constructs but also each other (i.e., correlate with each other), the statistical modelling of these constructs aimed to identify and characterise their mutual effects based on SEM (Chapter 3).

The benefits of using SEM analysis are twofold. First, it enables the establishment and characterisation of causal relationships between numerous correlated dependent and independent variables and/or factors. Second, SEM enables the visualisation and characterisation of a network of direct and indirect effects in which some independent variables of factors influence dependent variables or factors through other mediating variables. This gives rise to indirect effects that are not possible or that are difficult to consider in any other statistical model.

There are two approaches to SEM modelling with constructs. The first approach is to consider each construct together with its associated variables. This approach allows the possibility of effects between items associated with different factors and it directly considers the fact that the factors are determined by their respective items (measurable variables). However, this approach drastically increases the number of variables, which makes the developed models excessively complex. In addition to this, the large number of variables is likely to cause significant computational difficulties and it requires a sufficiently large sample size that is often not available (as in the current study based on the relatively small sample of 237 participants).

Therefore, as explained in Section 3.5.1, the second approach to SEM analysis is to consider the developed constructs as new (latent) numerical variables characterised by their factor scores obtained from the CFA modelling (Bollen, 1989; Marcoulides & Yuan, 2017; DiStefano *et al*., 2009). In this case, the survey items associated with each construct are used only to calculate the factor score for that construct and are not considered any further in the SEM model. As a result, the number of variables involved in the modelling dramatically reduces, which enhances simplicity, model clarity and model fits.

In addition to this, the use of developed constructs characterised by their factor scores enables a direct focus on the major general matters and trends for the constructs. For example, the effect of external risks (as an overarching construct) on project success (also perceived as a construct) can be determined instead of considering separate items that could be affected by a variety of misconceptions, misunderstandings and inappropriate perceptions.

It is also important that this second approach allows reliable SEM of the data with a significantly smaller sample size than what would be required for the first approach. The effects of any separate items could still be considered in this approach through the consideration of their factor loadings (strength of association) with the respective construct. Accordingly, most of the models in this section are developed and presented based on the dependent and independent constructs considered new latent numerical variables. Moreover, it should be noted that this approach to SEM analysis is an approximation that is typically used to avoid difficulties with the simultaneous consideration of all factors together with their associated variables.

Further, the survey contains two distinct types of dependent factors. The first type is related to perceptions of how efficiently the construction companies identified, assessed and managed risks. The second type is associated with perceptions of the level of success of construction projects. Given the significant differences between these two types of dependent factors, they give rise to distinct sets of SEM models considered separately in this section (although the relationships and agreement between them will be discussed).

Finally, because the modelling involves categorical variables that characterise the construction companies and study participants, mostly GSEM models will be developed, used and interpreted. SEM will only be used to evaluate the model fit (because model fit is not available in GSEM; see Section 3.5.3.4). The next section considers the GSEM models for the dependent variables to reflect how efficiently the construction companies identify, assess and manage risks.

5.3.1 Risk Management Practices

The dependent construct describing these matters is RM practice outcomes (Figure 5.1). In addition to this, a separate survey item, Q28 (Appendix 4), requested participants to rate the quality of risk management and planning in their company. This categorical variable can also be used as a dependent variable in a GSEM model. Therefore, two different dependent variables (RM practice outcomes and Q28) reflect similar matters associated with companies' ability to identify, assess and manage risks. The use of two different dependent variables is beneficial because it enables the determination of risk management efficiency from two different angles using two different GSEM models. The resulting cross-comparison and cross-validation of the outcomes increases confidence that the obtained outcomes are appropriate and valid.

5.3.1.1 RM Practice Outcomes (Model 1)

Figure 5.12 shows the GSEM model for the RM practice outcomes (Model 1). Table 5.7 presents the relevant regression coefficients and their respective *p*-values. As per Figure 5.12 and Table 5.7, several categorical variables measured by the survey instrument were re-categorised to ensure better statistical significance of their direct effects on RM practices and/or RM practice outcomes. Table 5.8 presents the definitions of the re-categorised categorical variables and their new categories used in the GSEM.

The model fit for the developed Model 1 (Figure 5.12) is presented by the GOF indices in the respective column in Table 5.9. As shown, all GOF indices for Model 1 demonstrate 'excellent' model fit. The value of CD demonstrates that the developed model can explain around 57% of the total variance of the endogenous variables (RM practices and RM practice outcomes).

Negative signs of several regression coefficients in Figure 5.12 and Table 5.7 reflect the negative effects between the corresponding variables/factors. For example, according to the developed GSEM model (Figure 5.12 and Table 5.7), the negative regression coefficient of −0.16 between RM practices and RM practice outcomes signifies that increasing the RM practices score by 1 results in decreasing the RM practice outcomes score by 0.16. This negative relationship between RM practices and RM practice outcomes can be understood from the consideration of the nature of these two factors.

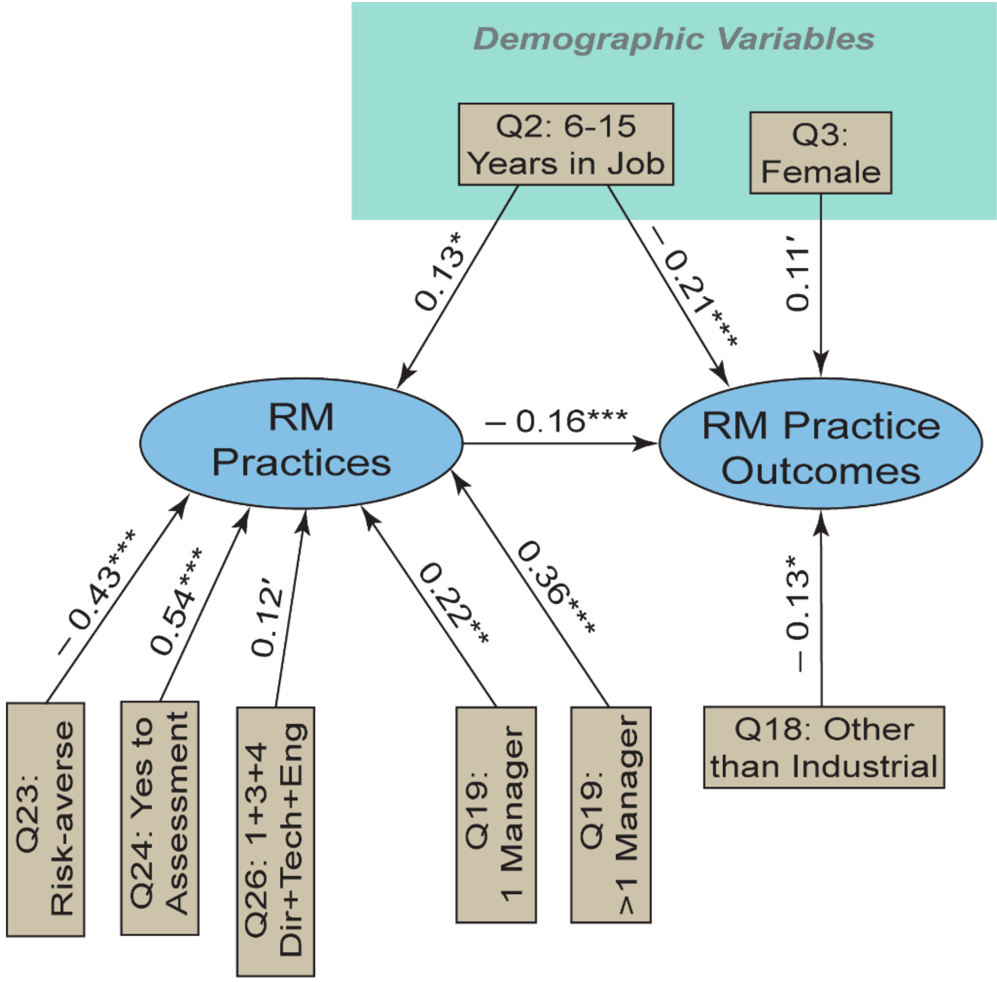


Figure 5.12: GSEM Model 1 – RM Practice Outcomes

Figure 5.12 shows the GSEM model for the RM practice outcomes factor (latent variables are shown by blue ovals). Regression coefficients are shown next to the arrows, indicating significant direct effects between the variables. Only statistically significant effects (with $p < 0.1$) are shown in this model. Asterisks indicate the levels of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$; (*) $0.01 \leq p < 0.05$; (′) $0.05 \leq p < 0.1$.

The RM practice outcomes factor (Figure 5.1) measures the difficulties and problems faced by companies in risk management (e.g., Q25.2–Q25.4). Therefore, the corresponding RM practice outcomes factor score contrasts with companies' success and efficiency in risk management. Increasing the efficiency of risk management must result in decreasing the RM practice outcomes score (i.e., decreasing difficulties and problems with risk management). In contrast, the construct of RM practices (Figure 5.3) measures the effectiveness of the risk management strategies and interaction with the risk management team. Increasing the RM practices score is equivalent to improving risk management strategies and interacting with the risk management team. The negative regression coefficient of −0.16 between RM practices and RM practice outcomes in Figure 5.12 and Table 5.7 expectedly shows that improving RM practices results in reducing difficulties with risk management (i.e., decreasing the RM practice outcomes score).

Table 5.7: GSEM Model 1 – RM Practice Outcomes

Response variables	Predictor variables		Regression coefficient	*p*-value
RM practice outcomes	RM practices		−0. 157	< 0.001
	Q3: Gender (Female versus male)		0.111	0.077
	Q2: Years in the job (from 6–15 years versus other)		–0.205	< 0.001
	Q18: Key company activities (Building, housing, infrastructure, other versus industrial)		–0.131	0.014
RM practices	Q19: Number of expert risk managers (versus 0)	One	0.216	0.002
		More than one	0.365	< 0.001
	Q2: Years in the job (from 6–15 years versus other)		0.133	0.023
	Q23: Risk culture (Risk-averse versus risk-taking and risk similar to competitors)		–0.433	< 0.001
	Q24: Risk assessment (yes versus no)		0.538	< 0.001
	Q26: Key decision-makers: Dir+Tech+Eng versus all other		0.121	0.077

Table 5.7 presents the outcomes of the GSEM model for the RM practice outcomes dependent factor, including the regression coefficients for the significant direct effects and their corresponding *p*-values. The different rows indicate the two sub-models with RM practice outcomes and RM practices as the dependent variables (see Figure 5.12). The RM practices sub-model indicates two categories of the Q19 variable. Table 5.8 outlines the categorical variables and their categories used in the GSEM models developed in this study.

Table 5.8: Re-Categorised Categorical Variables

Survey item	Base category (category 0)	Category 1	Category 2
Q1: Job Title	Contractor	Consultant	Client
Q2: Years in the job	≤ 5 years and > 15 years	6–15 years	N/A
Q3: Gender	Male	Female	N/A
Q8: Education	Diploma, graduate certificate, bachelor, master’s and other	PhD	N/A

Table 5.8: Re-Categorised Categorical Variables Continued

Survey item	Base category (category 0)	Category 1	Category 2
Q17: Company type	International, government, private	Public	N/A
Q18: Key company activities	Industrial	All other	N/A
Q19: Number of expert risk managers in the company	0	1	>1
Q23: Risk-related culture of the company	Risk-taking and similar to competitors	Risk-averse	N/A
Q24: Formal risk assessment process	No	Yes	N/A
Q26: Key decision-makers in the company	Project manager and+ other(s)	Director + technical manager + engineer	N/A

Figure 5.13a shows the average model-predicted dependence of the standardised RM practice outcomes score on the standardised RM practices score (not adjusted to any of the categorical variables). Figure 5.13b illustrates several examples of the effects of different categorical variables on this dependence. As explained above, the RM practice outcomes score decreases with an increasing RM practices score (Figures 5.13a and 5.13b). If all categorical variables are at zero categories, this dependence shifts upwards (compare lines 1 and 2 in Figure 5.13b). Therefore, compared with an average study participant, the employees corresponding to all zero categories are significantly more concerned about the difficulties experienced by their company in terms of finding, assessing and managing risks (line 1 in Figure 5.13b).

Table 5.9: Model Fit for GSEM Models

GOF indices	GSEM models				
	Model 1	Model 2	Model 3	Model 4	Model 5
p-value for χ^2	0.47	> 0.99	0.82	0.12	> 0.99
RMSEA	< 0.001	< 0.001	< 0.001	0.040	< 0.001
CFI	1	1	1	0.99	1
TLI	1	1	1	0.98	1
SRMR	0.017	< 0.001	0.015	0.024	< 0.001
CD	0.57	0.50	0.62	0.65	0.17

Note:
GOF indices (Appendix 5) for the developed GSEM models, calculated using of arguments in Section 3.5.3.4.

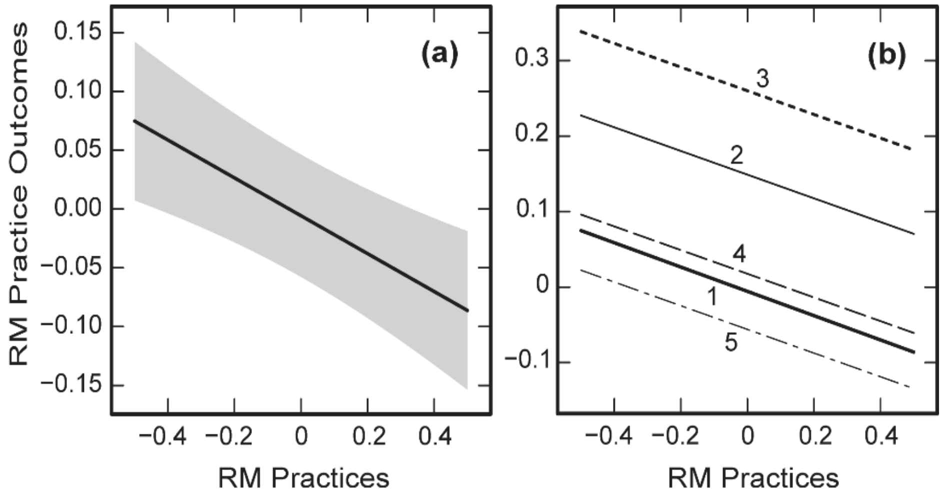


Figure 5.13: RM Practice Outcomes versus RM Practices

Figure 5.13 shows the predicted dependences of the standardised RM practice outcomes score on the standardised RM practices score. Sub-plot (a) is presented on average and is not adjusted for the categorical variables. The shaded band shows the 95% prediction intervals for the predicted dependence. Sub-plot (b) shows several dependences of RM practice outcomes on RM practices. Line 1 is the same as in sub-plot (a).

The other dependences are presented for: all categorical variables being at zero categories (line 2); for females (Q3) and all other categorical variables being at zero categories (line 3); for companies with key activities other than industrial (Q18) and all other categorical variables being at zero categories (line 4); and for employees with work experience between six and 15 years (Q2) and all other categorical variables being at zero categories (line 5).

As shown, females have a stronger perception that companies experience difficulties with risk management (compare lines 2 and 3 in Figure 5.13b and see the positive regression coefficient of 0.11 in Figure 5.12 and Table 5.7). For females, the RM practice outcomes score is greater than for males by 0.11 (Figure 5.12), although with borderline statistical significance.

Further, work experience in the job and key activities of the company also significantly modify the dependence (compare lines 4 and 5 with line 2 in Figure 5.13b). Interestingly, most of the variables characterising the company and study participants have direct effects on RM practices rather than RM practice outcomes (Figure 5.12), except for Q18 (key activities of the company), Q2 (work experience in the current role) and Q3 (gender), which have direct effects on RM practice outcomes. Therefore, most of the variables (apart from Q3 and Q18) have indirect effects on RM practice outcomes through the mediating variable of RM practices. A list of significant indirect effects on RM practice outcomes is presented below (Figure 5.12):

Q2 (Years in the job 6–15) → RM Practices → RM Practice Outcomes

$$(\Delta C = -0.021;\ p = 0.024) \tag{5.1}$$

Q19 (Number of expert risk managers = 1) → RM Practices → RM Practice Outcomes

$$(\Delta C = -0.035;\ p = 0.003) \tag{5.2}$$

Q19 (Number of expert risk managers > 1) → RM Practices → RM Practice Outcomes

$$(\Delta C = -0.058;\ p < 0.001) \tag{5.3}$$

Q23 (Risk-averse) → RM Practices → RM Practice Outcomes

$$(\Delta C = 0.069;\ p < 0.001) \tag{5.4}$$

Q24 (Yes to risk assessment) → RM Practices → RM Practice Outcomes

$$(\Delta C = -0.086;\ p < 0.001) \tag{5.5}$$

Q26 (Decision-makers: Director + Technical Manager + Engineer) → RM Practices → RM Practice Outcomes

$$(\Delta C = -0.019;\ p < 0.078) \tag{5.6}$$

where ΔC is the variation of the intercept (strength of the effect) as a result of switching from the base category of the respective categorical variable to the category (1 or 2; see Table 5.8). There were no indirect effects for Q18 (other than industrial type of company activities) and Q3 (gender).

The total effects for the variables are equal to their respective direct or indirect effects, except for Q2 (Years in the job 6–15; see Figure 5.12), for which the total effect is equal to the sum of the respective direct and indirect effects: Total Effect = Direct Effect + Indirect Effect = $-0.21 + (-0.021) = -0.231$ ($p < 0.001$). Therefore, for employees who were in their current job for 6–15 years (category 1; Table 5.8), the average RM practice outcomes score was 0.231 lower compared with those who were in their current job for less than equal to 5 years or greater than 15 years (category 0). That is, employees who were in their current job for 6–15 years perceived difficulties and problems faced by the company in risk management as significantly less severe compared with those who were in their current job for less than equal to 5 years or greater than 15 years.

This was an interesting outcome not highlighted in the existing literature. It is possible that employees who have either too little work experience or very extensive work experience were either overwhelmed by the complexity of their company's operations and risks (less experienced employees) or disillusioned by their extensive experiences in their company's risk management (highly experienced employees). Both aspects are likely to cause significantly increased perceptions of difficulties with identifying, assessing and managing risks, resulting in an increased RM practice outcomes score (which is a measure of difficulties with risk management). In contrast, employees with sufficient work experience (i.e., deep knowledge of their company's operations and projects), but who are not yet overwhelmed by any negative impressions and experiences, tend to evaluate their company's risk management practices more optimistically, which results in a lower RM practice outcomes score.

The strongest negative indirect effects on RM practice outcomes (characterising companies' difficulties with risk management) relate to Q24 ('Yes to formal risk assessment') and Q19 ('Presence of expert risk managers') (Equations 5.2, 5.3 and 5.5). This is an expected but important outcome for the construction companies. The strongest effect relates to Q24 (see Equation 5.5 and Figure 5.12). Thus, formal implementation of risk management may be the most important aspect of the successful management of risks. It can be said that formal risk assessment is a matter of priority for construction companies that intend to reduce their risks.

Similarly, having at least one or more expert risk managers in the company is highly beneficial in reducing difficulties with risk management (i.e., for the reduction of RM practice outcomes score) (Equations 5.2 and 5.3, Figure 5.12). This could be considered another recommendation for construction companies arising from the developed model (Figure 5.12).

There is a strong positive indirect effect from Q23 ('risk-averse culture in the company') on RM practice outcomes (see Equation 5.4). This new finding is somewhat unexpected and interesting. It can be concluded that more risk-averse companies are not those that effectively identify and manage risks but those that can be perceived as overcautious in their attempt to avoid any risks (which makes them more risk-averse) without identifying and managing them. Therefore, risk-averse companies are strongly and positively associated with perceived difficulties in identification, assessment and management of risks (Equation 5.4 and Figure 5.12).

An interesting suggestion could be drawn from here that simply avoiding risks is not the best option for a company in terms of effective risk management. A better approach is to identify and manage any risks in a reasonable way; in some cases, taking calculated and manageable risks is good for business and project success. This is a significant finding that may place positive contribution to risk management strategies in the UAE construction industry.

5.3.1.2 RM Quality Ratings (Model 2)

As explained in the introduction to Section 5.3.1, the second dependent variable used to evaluate the effect of RM practices on risk management effectiveness in UAE construction companies is Q28, which requested participants to rate the quality of risk management analysis and planning in their company as 'RM poor', 'RM good' or 'RM excellent' (Appendix 4). The resultant GSEM model with Q28 as the categorical dependent variable is shown in Figure 5.14. The respective regression coefficients and their *p*-values are presented in Table 5.10. As the dependent variable in this case is a categorical variable, GSEM was developed using the multinomial logistic regression, with the two categories 'RM good' or 'RM excellent' compared with the base category 'RM poor' (Figure 5.14).

This model is similar to that shown in Figure 5.12, but it uses the categorical dependent variable instead of RM practice outcomes. This enabled further validation of the developed models (Figures 5.12 and 5.14) through comparative analysis from different angles enabled by the different nature of the dependent variables.

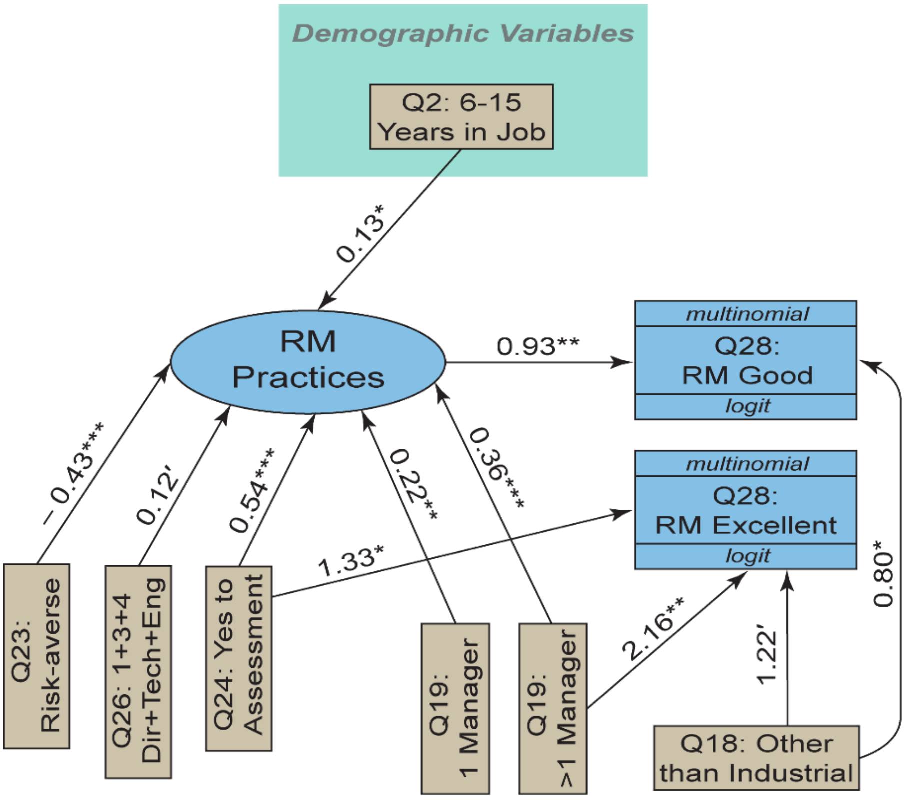


Figure 5.14: GSEM Model 2 – Quality Rating for RM

Figure 5.14 shows the GSEM model for the rating of quality of RM (Q28; Appendix 4). The regression coefficients are shown next to the arrows indicating significant direct effects between the variables. Only statistically significant effects (with $p < 0.1$) are shown in this model. Asterisks indicate the levels of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$; (*) $0.01 \leq p < 0.05$; (′) $0.05 \leq p < 0.1$.

Table 5.10: GSEM Model 2 – RM Quality Ratings

Response variables		Predictor variables		Regression coefficient	*p*-value
RM ratings (base category: poor)	1. Good	Q19: Number of expert risk managers (versus 0)	One	-	0.19
			More than one	-	0.41
		Q24: Risk assessment (yes versus no)		-	0.57
		Q18: Key company activities (Building, housing, infrastructure, other versus industrial)		0.80	0.044
		RM practices		0.93	0.007
	2. Excellent	Q19: Number of expert risk managers (versus 0)	One	-	0.75
			More than one	2.160	0.002
		Q24: Risk assessment (yes versus no)		1.33	0.033
		Q18: Key company activities (Building, housing, infrastructure, other versus industrial)		1.22	0.087
		RM practices		-	0.14
RM practices		Q19: Number of expert risk managers (versus 0)	One	0.22	0.002
			More than one	0.36	< 0.001
		Q23: Risk culture (Risk-averse versus risk-taking and risk similar to competitors)		–0.43	< 0.001
		Q24: Risk assessment (yes versus no)		0.54	< 0.001
		Q26: Key decision-makers: Dir+Tech+Eng versus all other		0.12	0.077
		Q2: Years in the job (from 6–15 years versus other)		0.13	0.023

Table 5.10 shows the outcomes of the GSEM model for the RM quality ratings (Q28) as the dependent categorical variable, including the regression coefficients for the significant direct effects and their corresponding *p*-values. The different rows indicate the three sub-models, with RM quality ratings and RM practices as the dependent variables (Figure 5.14). The RM practices sub-model indicates two categories of the Q19 variable.

As expected, the part of the model in Figure 5.14 that is related to the effects of the categorical variables on the RM practices latent variable remained the same as in Figure 5.12. Further, the part of the model related to the effects of the categorical variables and RM practices on the dependent variables is somewhat different in Figures 5.12 and 5.14.

Each of the two multinomial logits in Figure 5.14 is a function of probability of the respective ratings ‘RM good’ and ‘RM excellent’. Therefore, the regression coefficients corresponding to the relationships between the two multinomial logits and the other variables (Figure 5.14) can be used to determine the variations in the probabilities of different ratings (Q28) as functions of the changing categorical variables and/or RM practices score. For example, Figure 5.15 presents the predicted probability dependences for the three ratings categories in Q28: ‘RM poor’ (solid curve), ‘RM good’ (dashed curve) and ‘RM excellent’ (dotted curve). The values of the other categorical variables are as indicated in the caption for Figure 5.15.

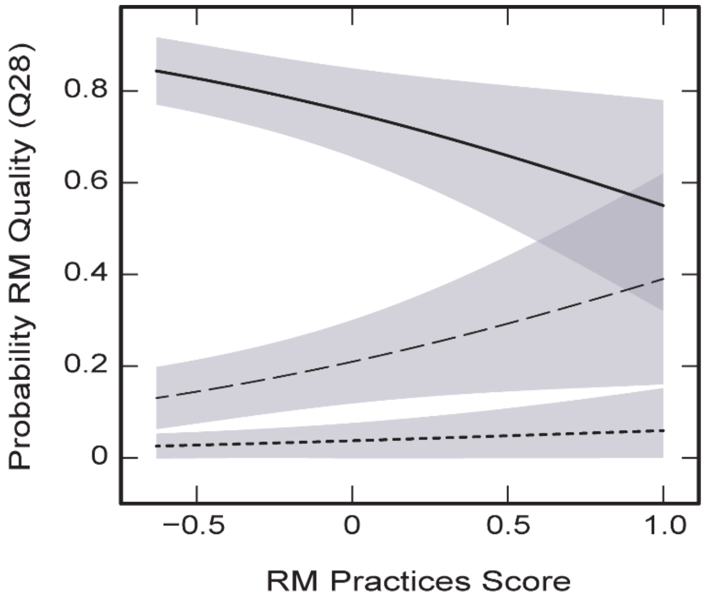


Figure 5.15: Probabilities of RM Quality Responses

Figure 5.13 presents the predicted dependences of the probabilities of the three different outcomes—poor (solid curve), good (dashed curve) and excellent (dotted curve)—in Q28 as functions of the standardised RM practices score. The shaded bands show the 95% prediction intervals for the predicted dependences. The figures are presented for non-industrial key company activities (Q18), no formal risk assessment process (Q24), no expert risk managers (Q19) and no adjustment for the other categorical variables.

As expected, the probability for the ‘RM poor’ rating decreases with an increasing RM practices score (Figure 5.15) because improving RM practices is expected to improve risk management, which is reflected by a reduction of the number (or probability) of ‘RM poor’ ratings. For the same reason, the probabilities of the ‘RM good’ and ‘RM excellent’ ratings increase with an increasing RM practices score (more than two times for the ‘RM good’ rating;

Figure 5.15). The rate of increasing probability of ‘RM excellent’ rating is rather slow. Therefore, increasing the RM practices score mostly causes the ‘RM poor’ rating to transform into the ‘RM good’ rating rather than ‘RM poor’ into ‘RM excellent’.

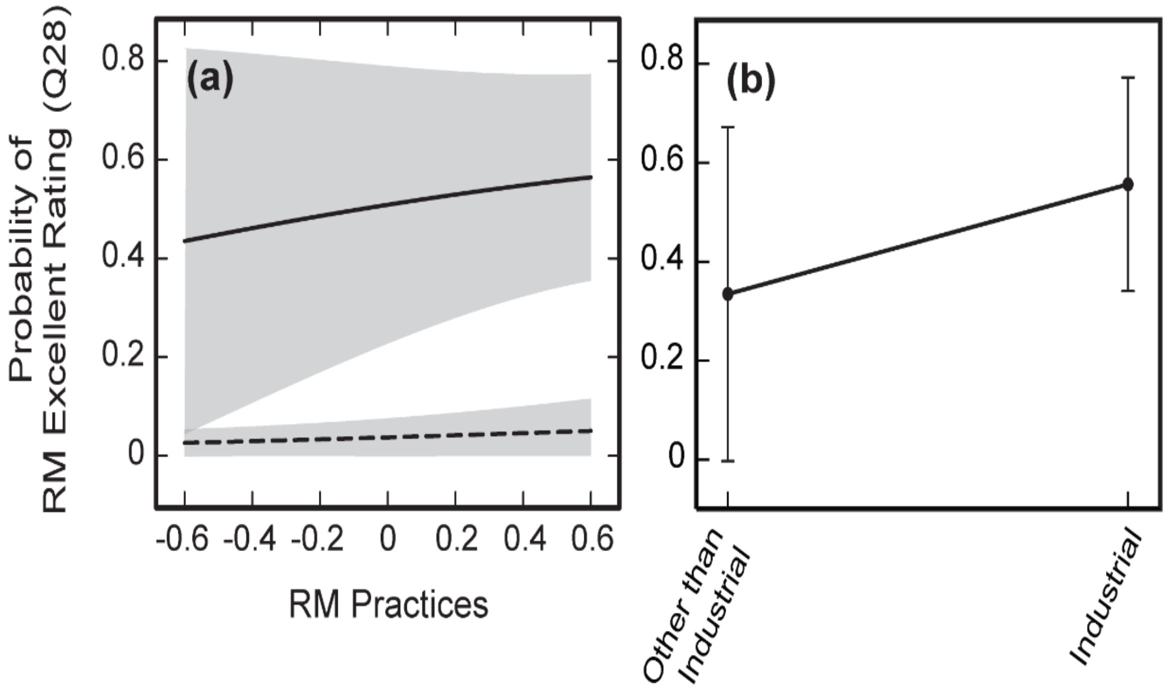


Figure 5.16: Probabilities of Excellent Rating for RM Quality

Figure 5.16 shows the predicted dependences of the probabilities of the RM excellent ratings: (a) on the standardised RM practices score with ‘Yes’ to a formal risk assessment process (Q24) (solid curve), ‘No’ to formal risk assessment process (Q24) (dashed curve), non-industrial key company activities (Q18), no expert risk managers (Q19) and no adjustment for other categorical variables; (b) on the categorical variable of key company activities (Q18) with an RM practice score = 0.5, ‘Yes’ to formal risk assessment process (Q24), > 1 expert risk managers (Q19) and no adjustment for other categorical variables. The shaded bands and error bars show the 95% prediction intervals for the presented dependences and/or points.

Further, Figure 5.16 illustrates the differences between the availability and absence of a formal risk assessment process (compare the two curves in Figure 5.16a) and between the industrial and other than industrial types of key company activities (the two points in Figure 5.16b). In particular, the existence of a formal risk assessment process is essential for the perceptions of good and excellent risk management (Figure 5.16a). For example, the probability of an ‘RM excellent’ rating drastically increases from less than 0.05 in the absence of a formal risk assessment process to around 0.5 in the presence of a formal risk assessment process (Figure

5.16a).

This drastic (of more than 10 times) improvement demonstrates the essential need for construction companies to have a formal risk assessment process for their projects and activities. This finding reinforces the recommendation derived from GSEM Model 1 (Figure 5.12) that implementing formal risk assessment should be a matter of priority for UAE construction companies and projects.

Second, there is a statistically significant difference in terms of their RM ratings between companies with industrial and other than industrial types of construction activities (Figure 5.16b). The greater 95% prediction interval for the other than industrial category is likely to be related to the greater diversity of companies included in this category. An interesting finding of this study is that construction companies with key activities in the industrial sector manage risks significantly better (with up to ~ 1.5 times larger probability of the 'RM excellent' rating) than companies with key activities other than in the industrial sector (Figure 5.16b).

There are only direct effects of the categorical variables Q18, Q19 and Q24 on the 'RM excellent' multinomial logit (Figure 5.14) and no indirect effects. Further, there are numerous indirect effects on the 'RM good' multinomial logit:

Q2 (Years in the job 6–15) → RM practices → 'RM good'
Q19 (Number of expert risk managers = 1) → RM practices → 'RM good'
Q19 (Number of expert risk managers > 1) → RM practices → 'RM good'
Q23 (Risk-averse) → RM practices → 'RM good'
Q24 (Yes to risk assessment) → RM practices → 'RM good'
Q26 (Decision-makers: director + technical manager + engineer) → RM practices → 'RM good'.

The same categorical variables indirectly affect the 'RM good' multinomial logit as on the RM practice outcomes in Model 1 (Figure 5.12). This confirms the outcomes of Model 1, although the actual calculation of the indirect effects in the case of multinomial regression (Model 2; Figure 5.14) is a significantly more complex task that is considered beyond the scope of this study.

Interestingly, there are no indirect effects on the 'RM excellent' multinomial logit in Model 2 (Figure 5.14). This suggests that the construct of RM practice outcomes was similar to the 'RM good' multinomial logit, but significantly different from the 'RM excellent' multinomial logit.

This is appropriate because the ‘RM excellent’ rating in Q28 is rather extreme and does not properly represent the overall trends similar to those characterised by the construct of RM practice outcomes.

As a result, the ‘RM excellent’ multinomial logit in Model 2 (Figure 5.14) behaves quite differently from the ‘RM good’ multinomial logit and the RM practice outcomes construct in Model 1 (Figure 5.12). That is, it is only the part of Model 2 that is associated with the ‘RM good’ multinomial logit that is similar to Model 1, whereas the part of Model 2 associated with the ‘RM excellent’ multinomial logit appears to be quite different.

Gender does not appear to be statistically significant in Model 2 (Figure 5.16), which raises questions about its overall significance in Models 1 and 2, particularly when considering the borderline level of significance in Model 1 (Figure 5.12). Therefore, the effects of gender in Models 1 and 2 (Figures 5.12 and 5.14) are probably inconclusive and future research should establish and properly characterise any such effects.

As explained in Section 3.5.3.4, the model fit for the developed GSEM Model 2 (Figure 5.14) can only be evaluated for the two separate parts of the model: the part with the RM practices construct as the dependent variable, and for the multinomial logistic regression involving multinomial logits for Q28 as the dependent variables and Q18, Q19, Q24 and RM practices construct as the independent variables (Figure 5.14).

The model fit for the part of Model 2 containing the RM practices construct as the dependent variable is presented by the GOF indices in Table 5.9. All GOF indices for this part of Model 2 demonstrate exceptional model fit. The value of CD demonstrates that this part of Model 2 can explain around 50% of the total variance of the endogenous variable (RM practices). A slightly lower CD of 0.50 (compared with 0.57 for Model 1) for this part of Model 2 may be related to the fact that this part of Model 2 is more limited than Model 1 and involves a larger number of dependent and independent variables.

For the second part of Model 2, which involves multinomial logits related to Q28 (Figure 5.14), the R^2 coefficient is around 0.15. Although this value is rather small (indicating that around 15% of the variance of Q28 can be explained by the multinomial logistic regression), it is only relevant to the part of the model whose overall CD should therefore be around at least 60%.

In general, comparisons of Models 1 and 2 corroborate each other’s validity. The signs of the regression coefficients are consistent between the models and most of the variables (except for the gender variable) are mutual to the models. The opposite signs for the regression coefficients for the effects of RM practices and Q18 on the dependent variables are explained by the opposite directions of the dependent variables in Models 1 and 2. In Model 1, RM practice outcomes is a measure of risk management difficulties (Figure 5.12), whereas in Model 2, the two multinomial logits highlight the success of risk management through the 'good' and 'excellent' ratings.

5.3.2 Project Success and Cultural and Economic Factors

As explained above in this chapter and Section 3.2.2, two different types of dependent variables are used in this study: one is associated with the participants' perceptions of the success or otherwise of the nature of the risk management by their company; the second is related to the success of the construction projects considering the existing risks and their management. The first type of variable was considered in Section 5.3.1 and led to the development of Models 1 and 2 (Figures 5.12 and 5.14). The second type of dependent variable is the project success construct (Figure 5.2). The modelling, therefore, aims to establish and characterise any direct or indirect effects of the developed independent constructs (Section 5.2.2) on project success (as the ultimate measure of successful risk management).

Further, the available sample size (237 observations) and the large number of constructs and demographic variables (Appendix 4) do not allow GSEM modelling to simultaneously involve all constructs and variables. Therefore, two separate GSEM models were developed to analyse the effects of cultural factors on project success (Model 3) and economic factors on project success (Model 4).

5.3.2.1 Cultural Effects (Model 3)

Figure 5.17 primarily considers the effects of cultural factors on project success in Model 3, adjusted for the indicated demographic and company variables. Table 5.11 shows all regression coefficients for Model 3 (including the ones not shown in Figure 5.17 for the demographic and company variables) and their corresponding significance that is denoted by asterisks representing the level of the *p*-values—a number of asterisks determines the level of significance.

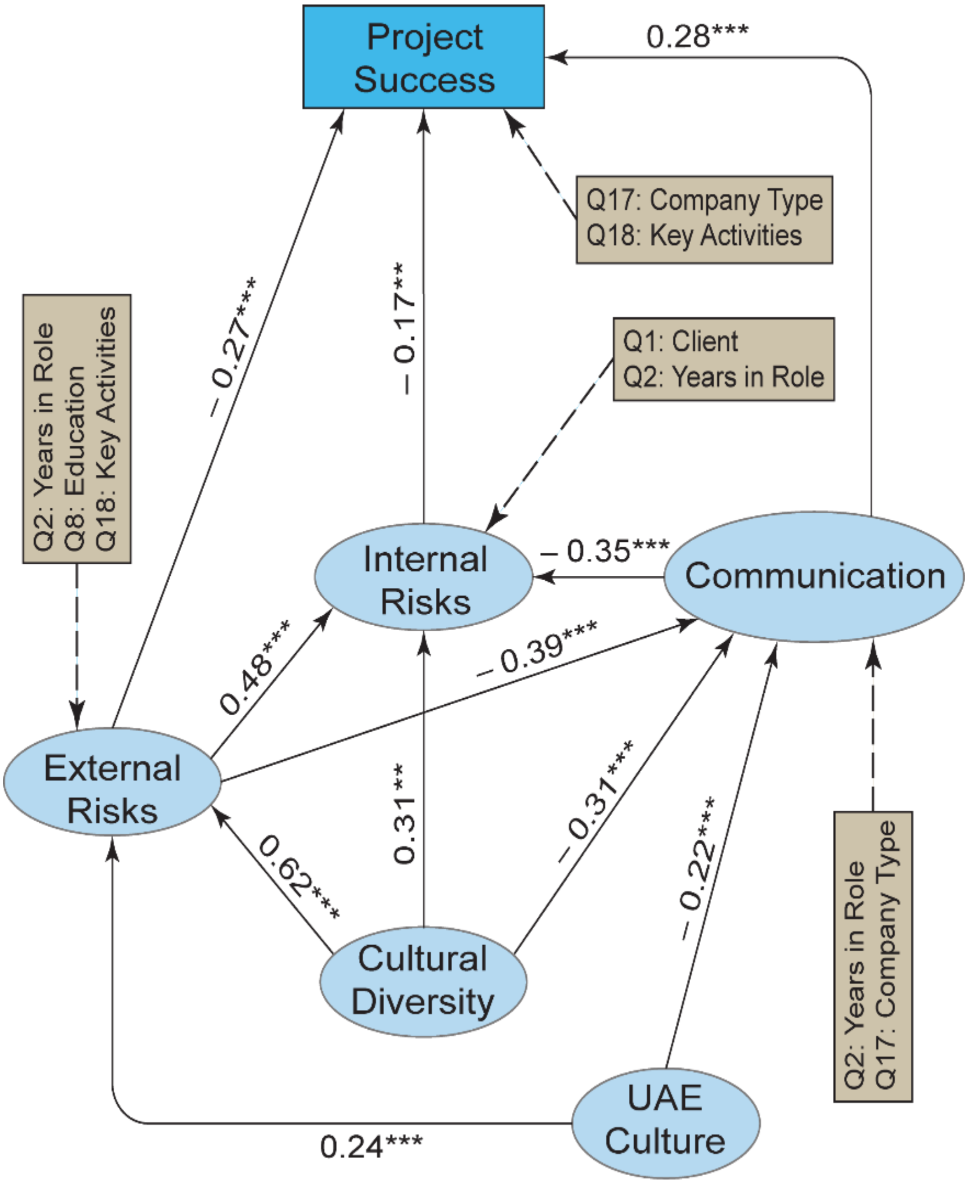


Figure 5.17: GSEM Model 3 – Cultural Factors and Project Success

Figure 5.17 shows the GSEM model for the project success construct (Figure 5.2), including the UAE culture and cultural diversity factors as the primary independent constructs. The regression coefficients are shown only for the direct effects between the factors. For simplicity of presentation, the significant measurable variables are grouped into boxes that correspond to each of the factors upon which these variables act (see Table 5.11 for the respective regression coefficients and their *p*-values). Only significant direct effects are shown in the model. Asterisks indicate the levels of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$.

Table 5.11: GSEM Model 3 – Cultural Factors and Project Success

Response variables	Predictor variables		Regression coefficient	*p*-value
Project success	External risk		–0. 2742	< 0.001
	Internal risk		–0.1746	0.003
	Communication		0.2789	< 0.001
	Q17: Company type (Public versus international, government and private)		–0.2212	0.086
	Q18: Key company activities (Building, housing, infrastructure and other versus industrial)		0.1175	0.079
External risks	UAE culture		0. 244	< 0.001
	Cultural diversity		0.620	< 0.001
	Q8: Education (Everything versus PhD)		0.289	< 0.011
	Q2: Years in the job (from 6–15 years versus other)		–0.122	0.034
	Q18: Key company activities (Building, housing, infrastructure, other versus industrial)		–0.149	0.014
Internal risks	External risk		0.4825	< 0.001
	Communication		–0.345	< 0.001
	Cultural diversity		0.3143	0.002
	Q1: Job title (versus contractor)	Consultant	-	0.129
		Client	0.272	0.004
	Q2: Years in the job (from 6–15 years versus other)		–0.359	< 0.001
Communication	External risk		–0.3919	< 0.001
	UAE culture		0.2230	< 0.001
	Cultural diversity		–0.3143	< 0.001
	Q2: Years in the job (from 6–15 years versus other)		0.2408	< 0.001
	Q3: Gender (Female versus male)		-	0.185
	Q17: Company type (Public versus international, government and private)		–0.2426	0.025

Table 5.11 shows the outcomes of the GSEM model for the project success factor and the developed cultural constructs, including the regression coefficients for the significant direct effects and the corresponding *p*-values. The different columns indicate the four sub-models, with the indicated constructs as the dependent latent variables (Figure 5.17). The internal risks sub-model indicates two categories of the Q1variable.

In particular, the two cultural factors (UAE culture and cultural diversity) have numerous significant direct and indirect effects on the other constructs (Figure 5.17). Importantly, they do not have any significant direct effects on project success, but they act only through other factors by way of significant indirect effects. It is important to note that the categorical company and demographic variables also have numerous direct and indirect effects on the constructs, including project success (Figure 5.17). However, this analysis focuses on the effects of the developed constructs on project success because of their primary importance for successful risk management.

The significant indirect effects of the two cultural factors on project success (Figure 5.17), including their corresponding regression coefficients and *p*-values, are presented in Equations 5.7 through to 5.19:

$$\text{UAE culture} \rightarrow \text{Communication} \rightarrow \text{Project success}$$
$$(K = -0.062;\ p < 0.001) \tag{5.7}$$

$$\text{UAE culture} \rightarrow \text{Communication} \rightarrow \text{Internal risks} \rightarrow \text{Project success}$$
$$(K = -0.013;\ p = 0.004) \tag{5.8}$$

$$\text{UAE culture} \rightarrow \text{External risks} \rightarrow \text{Project success}$$
$$(K = -0.065;\ p < 0.001) \tag{5.9}$$

$$\text{UAE culture} \rightarrow \text{External risks} \rightarrow \text{Internal risks} \rightarrow \text{Project success}$$
$$(K = -0.020;\ p = 0.004) \tag{5.10}$$

$$\text{UAE culture} \rightarrow \text{External risks} \rightarrow \text{Communication} \rightarrow \text{Project success}$$
$$(K = -0.026;\ p < 0.001) \tag{5.11}$$

$$\text{UAE culture} \rightarrow \text{External risks} \rightarrow \text{Communication} \rightarrow \text{Internal risks} \rightarrow \text{Project success}$$
$$(K = -0.0056;\ p = 0.004) \tag{5.12}$$

$$\text{Cultural diversity} \rightarrow \text{Communication} \rightarrow \text{Project success}$$
$$(K = -0.087;\ p < 0.001) \tag{5.13}$$

$$\text{Cultural diversity} \rightarrow \text{Communication} \rightarrow \text{Internal risks} \rightarrow \text{Project success}$$
$$(K = -0.018;\ p = 0.004) \tag{5.14}$$

$$\text{Cultural diversity} \rightarrow \text{Internal risks} \rightarrow \text{Project success}$$

$(K = -0.053;\ p = 0.004)$ (5.15)

Cultural diversity → External risks → Project success

$(K = -0.167;\ p < 0.001)$ (5.16)

Cultural diversity → External risks → Internal risks → Project success

$(K = -0.051;\ p = 0.004)$ (5.17)

Cultural diversity → External risks → Communication → Project success

$(K = -0.068;\ p < 0.001)$ (5.18)

Cultural diversity → External risks → Communication → Internal risks → Project success

$(K = -0.014;\ p = 0.004)$ (5.19)

The total effects of the UAE culture construct and cultural diversity construct on project success can thus be calculated as the sum of all respective indirect effects:

Total effect for UAE culture = −0.192 ($p < 0.001$) (5.20a)

Total effect for cultural diversity = −0.458 ($p < 0.001$) (5.20b)

The large number of statistically significant and strong indirect effects in the model (Figure 5.17) demonstrates the need for the developed GSEM model. The indirect effects in the presence of numerous categorical variables cannot be adequately characterised or considered other than in a GSEM model. Given the rather large (and, in some cases, dominant) contribution of the indirect effects to the total effects, the adopted analytical methodology is appropriate; and that the developed GSEM model for the cultural factors (Figure 5.17) and the other four GSEM models (see above and below in this chapter) are essential for the analysis of the available survey data.

Further, all indirect effects of both cultural factors on project success are negative (Equations 5.7–5.19). This means that the project success factor score reduces with increasing factor scores for UAE culture and cultural diversity. In other words, cultural features and diversity are detrimental for project success in the UAE construction industry. The only exceptions are Q31.4 (from the UAE culture construct; Figure 5.9) and Q31.15 (from the cultural diversity construct; Figure 5.10), which have negative factor loadings and therefore positive effects on project success (unlike all other items associated with the two cultural constructs).

For example, Q31.1 (‘Emiratis value personal trust as an important ingredient in business transactions') has a positive factor loading in the UAE culture factor (Figure 5.9). Therefore, the participants who agreed that Emiratis value personal trust tended to disagree that the construction project was successful (because of the negative relationship between UAE culture and project success; Equation 5.20a). Thus, the fact that Emiratis value personal trust in business transactions can be interpreted as detrimental to the success of construction projects (and for effective risk management).

Similarly, other cultural aspects include that the Emiratis prefer to conduct business face to face (Q31.2) and that Emiratis like to get to know the person they are doing business with before they do business. (Q31.3). There is a strong vertical hierarchy structure in most Emirate companies (Q31.5) that may also have detrimental effects on project success (with the strongest negative effect coming from Q31.1 and Q31.2; see the discussion of Figure 5.9). Further, because of the significant negative loading for Q31.4, it can be said that a more stringent attitude towards 'time' in the UAE (Q31.4) has a positive effect on project success. This is the only identified aspect of the UAE culture that is beneficial for the success of construction projects.

Similarly, Q31.14, Q31.16, Q31.17 and Q31.19, which are associated with the cultural diversity construct (Figure 5.10), are positively associated with this construct and therefore have a negative effect on the success of construction projects (because of the negative relationship between cultural diversity and project success; Equation 5.20b). The only exception is Q31.15, which has a negative factor loading and therefore a positive effect on project success.

Therefore, diversity of educational background is beneficial for the success of projects and towards the operation of risk management in the UAE construction industry. However, it is important to note that this finding is based on the factor loading that has the smallest magnitude and the lowest statistical significance (p = 0.040) compared with the other four items (Figure 5.10). While being within the conventional limits for statistical significance, this finding may require further confirmation through future research.

Moreover, the total effect of cultural diversity on project success is more than two times larger in magnitude than that of UAE culture (compare Equations 5.20a and 5.20b). Therefore, to improve risk management and project success in the UAE construction industry, the major focus should be on the management of cultural 'diversity issues' rather than general cultural matters (whose effects are around two times weaker than that of cultural diversity).

As a result, the recommendation to UAE construction companies is to adequately manage the existing cultural diversity of the workforce, including through effective dispute-resolution procedures and management of language diversity and differences in workplace cultures and decision-making processes. This approach should have a significant benefit for the success of future projects and risk management in the UAE construction industry.

As shown in Figure 5.17, cultural diversity and UAE culture tend to enhance (through several direct and indirect effects) external risks and internal risks and decrease the efficiency of communication. This is expected because, for example, cultural diversity is likely to impede communication and interaction between people of different cultures, languages and traditions, which contributes to risks and difficulties in relation to succeeding in projects and workplace tasks (Al-Hajj & Sayers, 2014; Al Mousli & El-Sayegh, 2016; Biygautane, 2017; El-Sayegh 2008; Wu *et al*., 2017).

Similarly, cultural and language diversities are likely to contribute to difficulties with site safety arrangements (Q29.4), project management, planning and budgeting (Q29.11), human resource matters (Q29.14) and project design and assessment (Q29.15). This causes a negative effect of cultural diversity on internal risks (Figure 5.5), thereby creating another path in the GSEM structure (Figure 5.17) for cultural diversity to affect project success through the mediation of internal risks.

Cultural diversity and UAE culture also affect external risks, for example, by exacerbating corruption, creating inconsistencies in the application of new regulations and contributing to cultural differences between project stakeholders. This results in indirect effects of cultural diversity and UAE culture on project success through external risks (see Equations 5.9–5.12 and 5.16–5.19).

Figures 5.18 and 5.19 show the dependences of the direct effects of communication, internal risks and external risks on project success. Figure 5.18a illustrates the rate of increasing project success with an increasing communication score (including the corresponding 95% prediction interval). Figure 5.18b illustrates (using two examples) the effects of the categorical variables on this dependence. In particular, project success and risk management are better in companies with non-industrial key activities and other than publicly owned (see the dashed and dotted lines in Figure 5.18b). It can thus be concluded that public ownership of construction companies is inefficient compared with all other types of ownership (Figure 5.18b).

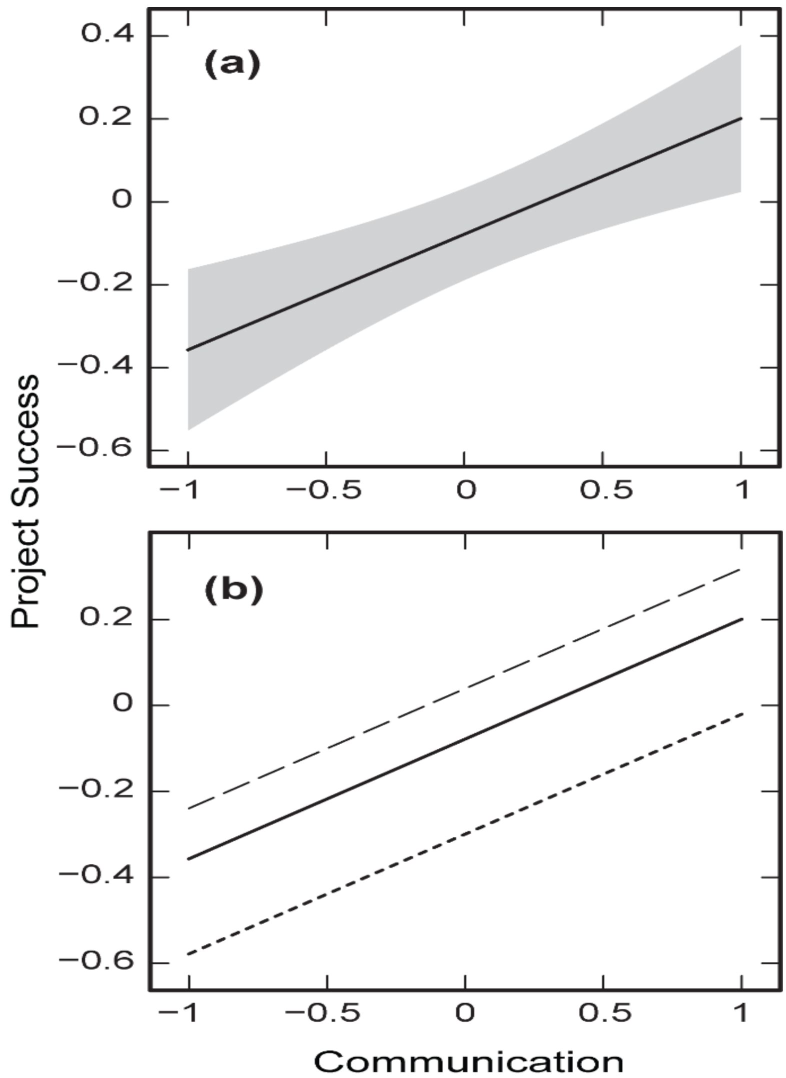


Figure 5.18: Project Success versus Communication

Figures 5.19a and 5.19b show similar dependences of the project success score on external risks and internal risks respectively. An important conclusion drawn from these figures is that external risks have a significantly stronger effect on project success than internal risks. This is demonstrated by a significantly larger slope of the line in Figure 5.19a compared with the line in Figure 5.19b, as well as by the larger regression coefficients for the direct effects between external risks and project success (Figure 5.17 and Table 5.11).

Figure 5.19 shows the predicted dependences of the standardised project success score on the standardised communication score for: (a) zero categories for all categorical variables, including the 95% prediction interval shown by the shaded band; and (b) solid line: the same as in (a), dashed line: for building, housing, infrastructure and other key company activities (Q18) and zero categories for all other categorical variables, and dotted line: for public companies (Q17) and zero categories for all other categorical variables. For all presented graphs, the other numerical (latent) variables are taken to have zero values (which are close to their average standardised values).

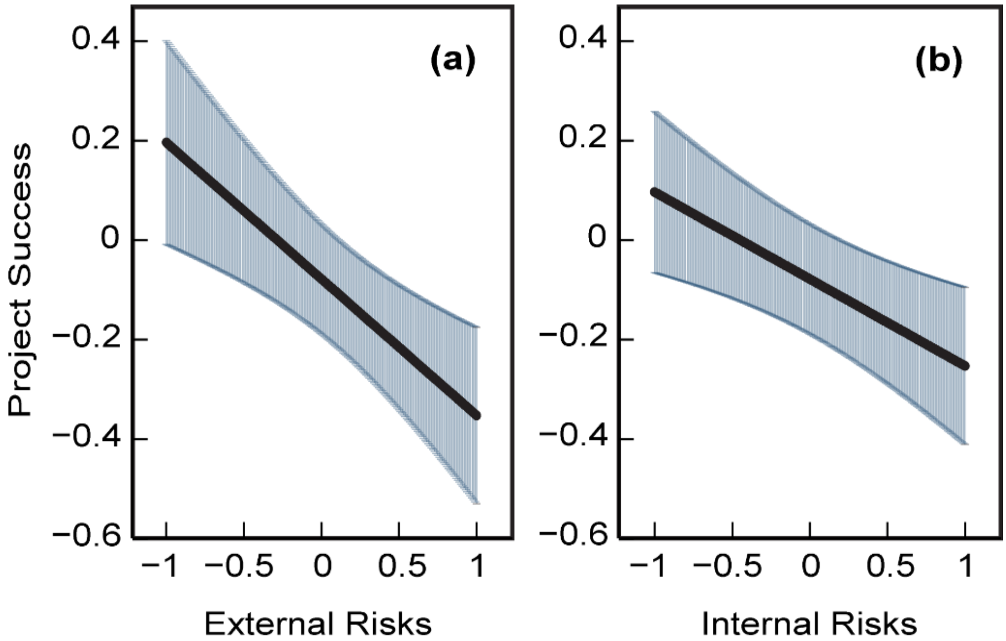


Figure 5.19: Project Success versus External and Internal Risks

Figure 5.19 shows the predicted dependences of the standardised project success score on the standardised scores for: (a) the external risks factor and (b) the internal risks factor, including the corresponding 95% prediction intervals. All categorical variables are assumed to be zero categories and the remaining standardised numerical variables are zero.

Note that the dependences shown in Figures 5.18 and 5.19 represent only the direct effects of the communication, external risks and internal risks constructs on project success (see also Figure 5.17 and Table 5.11). To determine the total effects of these three constructs on project success, the direct effects must be added to the corresponding indirect effects. As the internal risks factor has only a direct effect on project success (Figure 5.17), it equals its total effect. Communication has one direct effect on project success (with a coefficient of 0.28; Figure 5.17) and one indirect effect through internal risks (with the regression coefficient of $(-0.35)\times(-0.17) = 0.0595$). The external risks factor has one direct effect on project success (with the coefficient of -0.27; see Figure 5.17) and three indirect effects:

External risks → Internal risks → Project success

$$(K = -0.082;\ p = 0.004) \tag{5.21}$$

External risks → Communication → Project success

$(K = -0.109; p < 0.001)$ (5.22)

External risks → Communication → Internal risks → Project success

$(K = -0.023; p = 0.004)$ (5.23)

Therefore, the total effects of communication and external risks must be calculated as the sums of their direct and indirect effects:

Total effect of communication = 0.28 + 0.0595 = 0.3395 (5.24a)

Total effect of external risks = −0.484 (5.24b)

Total effect of internal risks = −0.17 (5.24c)

It follows from here that the total effects of communication and external risks are significantly larger than that of the internal risks factor. Thus, increasing the standardised communication score by 1 results in increasing the project success score by around 0.3395. The same increase by 1 of the standardised external risks score or internal risks score results in decreasing the project success score by 0.484 and 0.17 respectively.

The resulting recommendation for efficient risk management is therefore to give priority to managing communication issues and external risks (wherever management of such external risks is within the company's reach). Internal risks appear to be less important, although they should not be neglected.

The validity of the developed Model 3 (Figure 5.17) is confirmed by the respective set of GOF indices in Table 5.9 showing a good model fit and a CD value of around 62%. As explained above, this means that Model 3 explains around 62% of the total variance of the involved endogenous variables. This is a good outcome because it demonstrates that only around 38% of the total variance of the endogenous variables require consideration of some other variables and/or factors not involved in Model 3.

5.3.2.2 Economic Effects (Model 4)

Figure 5.20 shows Model 4 primarily considering the effects of economic and financial factors on project success, adjusted for the indicated demographic and company variables. Table 5.12 shows all regression coefficients for Model 4 (including the ones not shown in Figure 5.20 for the demographic and company variables) and their corresponding significance of the *p*-values.

The three economic factors—namely financial risks, contract importance and R&T importance—have numerous significant direct and indirect effects on each other and on internal risks and project success (Figure 5.20). Similar to Model 3, internal risks in Model 4 have relatively weak direct effects on project success (Figure 5.20). This confirms the previous finding that internal risks (Figure 5.5) are not a priority in relation to the development of effective and successful project management.

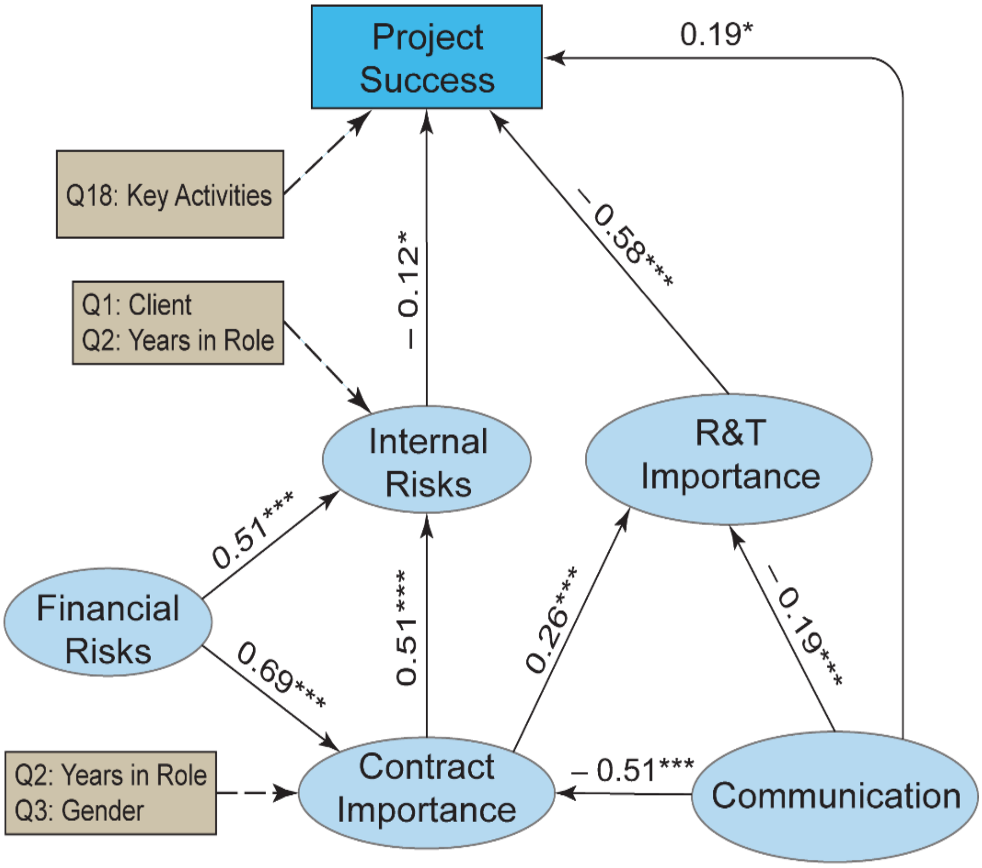


Figure 5.20: GSEM Model 4 – Economic Factors and Project Success

Figure 5.20 shows the GSEM model for the project success construct (Figure 5.2) and includes the economic constructs of financial risks (Figure 5.6), contract importance (Figure 5.7) and R&T importance (Figure 5.8) as the independent constructs. The regression coefficients are shown only for the direct effects between the factors. For simplicity of presentation, the significant measurable variables are grouped into boxes corresponding to each factor upon which these variables act (see Table 5.12 for the respective regression coefficients and their *p*-values). Only significant (with $p < 0.1$) direct effects are shown in the model. Asterisks indicate the levels of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$; (*) $0.01 \leq p < 0.05$.

Further, the structures of Models 3 and 4 are somewhat different. Communication does not have any significant direct effects on the primary independent cultural constructs in Model 3 (Figure 5.17), whereas in Model 4, communication directly affects contract importance and R&T importance (Figure 5.20). This is expected because communication elements are intuitively important for an effective contract and for the management of R&T.

Table 5.12: GSEM Model 4 – Economic Factors and Project Success

Response variables	**Predictor variables**		**Regression coefficient**	***p*-value**
Project success	Internal risk		–0.122	0.044
	R&T importance		–0.578	< 0.001
	Financial risks		-	0.351
	Communication		0.185	0.019
	Q17: Company type (Public versus international, government and private)		-	0.157
	Q18: Key company activities (Building, housing, infrastructure and other versus industrial)		0.136	0.034
Internal risk	Q1: Job title (versus contractor)	Consultant	-	0.187
		Client	0.233	0.005
	Q2: Years in the job (from 6–15 years versus other)		–0.192	0.002
	Contract importance		0.510	< 0.001
	Financial risks		0.508	< 0.001
R&T importance	Contract importance		0.263	< 0.001
	Communication		–0.185	< 0.001
Contract importance	Financial risks		0.691	< 0.001
	Communication		–0.508	< 0.001
	Q2: Years in the job (from 6–15 years versus other)		–0.240	< 0.001
	Q3: Gender (Female versus male)		0.136	0.088

Table 5.12 shows the outcomes of the GSEM model for the project success factor and the developed three economic constructs, including the regression coefficients for the significant direct effects and their corresponding *p*-values. The different columns indicate the four sub-models with the indicated constructs as the dependent latent variables (see Figure 5.20). The internal risks sub-model indicates two categories of the Q1variable.

The negative sign of the regression coefficient between the communication construct and contract importance can be explained as follows. The communication factor measures the level and efficiency of communication and interaction within the company and with the consultants and clients (Figure 5.11). Contract importance measures the extent to which contractual matters affect (or are important for) the success of the project (see Q30 in Appendix 4). Therefore, the negative relationship between the communication construct and contract importance means that increasing communication efficiency (i.e., increasing communication factor score by 1) results in decreasing the perceived importance of the contractual matters for the success of the project (i.e., in decreasing contract importance score by 0.51; Figure 5.20). That is, better communication tends to compensate for the perceived need to develop a clear and efficient contract. Problems with communication caused by UAE culture, cultural diversity and external risks (Figure 5.17) cause the greater perception of the need for a clear and efficient contract (Figure 5.20).

This important finding highlights that deficiencies and shortcomings in communication (including those caused by cultural issues and external risks) can be counteracted through the development of a more efficient contract that addresses financial liabilities; budget allocations and bills of quantities; accounting standards and terms and conditions; project planning and duration; and that involves reputable market consultants. Alternatively, appropriate and efficient communication tends to compensate for contractual deficiencies, thereby reducing the perception of their importance for project success.

Similarly, communication has a significant direct effect on R&T importance (Figure 5.20). This effect is also negative; that is, improving the communication score by 1 results in a reduction of the R&T importance score by 0.19 (Figure 5.20). Once again, this is because deficiencies or problems with communication (e.g., caused by UAE culture, cultural diversity and external risks) tend to strengthen the perception of the importance of R&T matters for the success of the project. If communication is appropriate and efficient, the perception of R&T importance is reduced. This may be because good communication leads to efficient resolution of R&T issues, thereby reducing the perception of influence of these issues on project success.

Financial risks have expected positive and strong effects on contract importance and internal risks (Figure 5.20). For example, increasing the financial risks score by 1 results in increasing contract importance by 0.69. Problems with financial matters, costs and payments increase the perception of importance of a clear and efficacious contract, which is the reason for the indicated strong relationship.

Interestingly, although the contract importance factor was developed based on survey items that asked participants about their perceptions regarding the importance of contractual matters for the success of construction projects, contract importance does not have a significant direct effect on project success (Figure 5.20). Contract importance (and financial risks) has only indirect effects on project success, whereas internal risks and R&T importance have only direct effects on project success (Figure 5.20). The communication construct has both direct and indirect effects on project success (Figure 5.20).

The indirect effects from communication, contract importance and financial risks can be listed as follows:

Communication → R&T importance → Project success

$$(K = 0.110;\ p < 0.001) \tag{5.25}$$

Communication → Contract importance → R&T importance → Project success

$$(K = 0.077;\ p < 0.001) \tag{5.26}$$

Communication → Contract importance → Internal risks → Project success

$$(K = 0.031;\ p = 0.045) \tag{5.27}$$

Contract importance → R&T importance → Project success

$$(K = -0.151;\ p < 0.001) \tag{5.28}$$

Contract importance → Internal risks → Project success

$$(K = -0.061;\ p = 0.045) \tag{5.29}$$

Financial risks → Contract importance → Internal risks → Project success

$$(K = -0.042;\ p = 0.045) \tag{5.30}$$

Financial risks → Contract importance → R&T importance → Project success

$$(K = -0.101;\ p < 0.001) \tag{5.31}$$

Financial risks → Internal risks → Project success

$$(K = -0.061;\ p = 0.045) \tag{5.32}$$

The total effects of communication, contract importance and financial risks on project success were again calculated as the sums of all respective indirect and direct effects:

Total effect for communication = 0.408 ($p < 0.001$) (5.33a)

Total effect for contract importance = −0.212 ($p < 0.001$); (5.33b)

Total effect for financial risks = −0.204 ($p < 0.001$) (5.33c)

Total effect for R&T importance = −0.58 ($p < 0.001$) (5.33d)

Total effect for internal risks = −0.12 ($p = 0.044$) (5.33e)

For Model 3, the presence of numerous, highly significant and strong indirect effects once again highlights the essential importance of the developed GSEM models as the major analytical tools in this study. Without such models, it would have been impossible to correctly evaluate and characterise the determined indirect effects or correct variable effects of project success. It also would have been impossible to see the uncovered effects of the paths towards project success, including the indicated causal relationships between the constructs and variables.

Further, Equations 5.33a–5.33e show that the communication and R&T importance constructs have dominant effects on project success, with total effects of 0.408 and −0.58, respectively. Contract importance and financial risks have around two times smaller effects on project success. Therefore, the major focus of construction managers should be on the communication and R&T matters that are most crucial for the success of UAE construction projects.

Considering the previously discussed outcomes for Model 3 (see the discussions of Equations 5.7–5.24), it can be concluded that, of the eight constructs—financial risks, contract importance, R&T importance, communication, internal risks, external risks, UAE culture and cultural diversity—the most important ones for the success of construction projects are external risks, R&T importance, cultural diversity and communication. This is an important finding from Models 3 and 4.

All direct, indirect and total effects of communication on project success are positive in both Models 3 and 4 (see Figures. 5.17 and 5.20). This is expected, as improvements in communication and its efficiency are expected to result in improvements in project success. Similarly, all the direct and indirect effects associated with financial risks are negative (Figure 5.20). This is also expected, as greater financial risks and instability characterised by the financial risks construct (Figure 5.6) should decrease the level of project success.

Further, all direct and indirect effects of contract importance and R&T importance on project success are negative (Figure 5.20). This can be perceived as somewhat counterintuitive because improvements in construction contracts and efficient resolution of R&T issues are typically expected to boost the successful implementation of construction projects. However, it is important to note that the developed constructs of contract importance and R&T importance are not measures of improvements in construction contracts and/or efficient resolutions of R&T issues.

These constructs characterise participants' perceptions of whether the contractual and R&T issues are important for the success of construction projects. It is argued that these perceptions are significantly influenced by psychological factors (confounders), resulting in a negative relationship between contract importance and project success and between R&T importance and project success.

For example, Model 4 was constructed under the assumption that the project success factor is a dependent variable (Figure 5.20). However, it is likely that it will have a reverse confounding influence on contract importance. Employees at successful companies (that tend to succeed in their projects for various reasons) may perceive contractual and R&T issues as less important, even though these issues might still exist. Success with project implementation despite the presence of contractual and/or R&T deficiencies is likely to reduce the perceptions of the importance of any such deficiencies for the success of the project.

In contrast, employees at less successful companies are likely to look for reasons for their failures and may perceive contractual and R&T issues as more important, thereby boosting the scores for the contract importance and R&T importance constructs. In this way, project success is likely to have a confounding effect (not considered in Model 4) on contract importance and R&T importance, resulting in negative relationships between contract importance and project success and between R&T importance and project success (Figure 5.20). Detailed analysis of this confounding effect is impeded in the current project by the structure of the survey instrument (which was not designed to capture this effect) and the relatively sample size of 237 participants. Therefore, this issue can be considered a limitation of this study, and it requires further research.

Each of the four factors identified as the most critical (external risks, R&T importance, cultural diversity and communication) for the success of construction projects is associated with the respective measurable variables (survey items; see Figures 5.4, 5.8, 5.10 and 5.11). The most important items previously identified for each of these four constructs can therefore be regarded as the most critical risks for the success of UAE construction projects:

Q29.1: Corruption of government officials (Figure 5.4);
Q29.12: Inadequate forecast of market demand (Figure 5.4);
Q30.10: Lack of adequate financial accountability and management (Figure 5.8);
Q31.14: Language diversity (Figure 5.10);
Q31.17: Diversity of decision-making processes (Figure 5.10);
Q31.19: Lack of effective dispute-resolution procedures (Figure 5.10);
Q31.8: Large communication gap between the contractor and the client (Figure 5.11);
Q31.6: Lack of effective system of communication of risks (Figure 5.11);

Q31.7: Lack of effective system of communication of risk mitigation strategies (Figure 5.11); and

Q31.10: Large communication gap between the contractor and the employees (Figure 5.11).

Adequately addressing and managing these risks is likely to provide the most benefits to construction companies in terms of the most effective risk management.

Figures 5.21 and 5.22 show the dependences of the direct effects of R&T importance and financial risks on project success. Figure 5.21a illustrates the rate of increasing project success with an increasing R&T importance score (including the corresponding 95% prediction interval), whereas Figure 5.21b illustrates (using two examples) the effects of categorical variables on this dependence. In particular, similar to Figure 5.18, project success and risk management are better in companies that have non-industrial key activities and other than publicly owned (compare the dashed and dotted lines in Figure 5.21b). This confirms that public ownership of construction companies is the most inefficient compared with other types of ownership (Biygautane, 2017; Ling *et al*., 2012; Sambasivan *et al*., 2017).

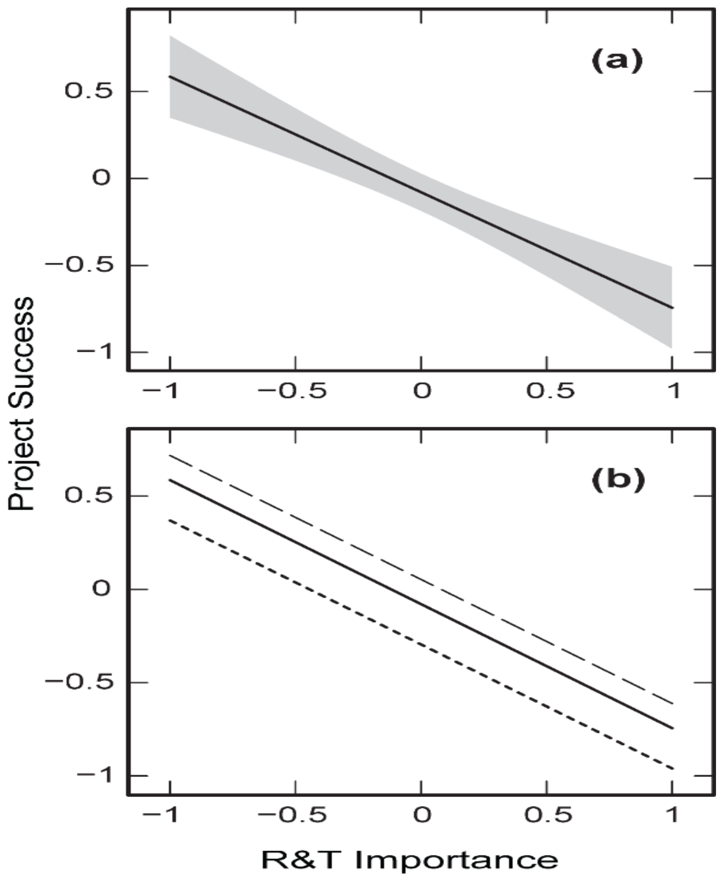


Figure 5.21: Project Success versus R&T Importance

Figure 5.21 shows the predicted dependences of the standardised project success score on the standardised R&T importance score for (a) zero categories for all categorical variables, including the 95% prediction interval shown by the shaded band; and (b) solid line: the same as in (a), dashed line: for building, housing, infrastructure and other key company activities (Q18) and zero categories for all other categorical variables, and dotted line: for public companies (Q17) and zero categories for all other categorical variables. For all presented graphs, the other numerical (latent) variables were taken to have zero values (which were close to their average standardised values).

Figures 5.22a and 5.22b compare the dependences of the project success score on R&T importance and financial risks, respectively. An important conclusion is that R&T importance has a significantly stronger effect on project success than financial risks. This is demonstrated by the larger slope of the line in Figure 5.22a compared with the line in Figure 5.22b, and by the larger regression coefficients for the direct effects between the R&T importance factor and project success (Figure 5.20 and Table 5.12).

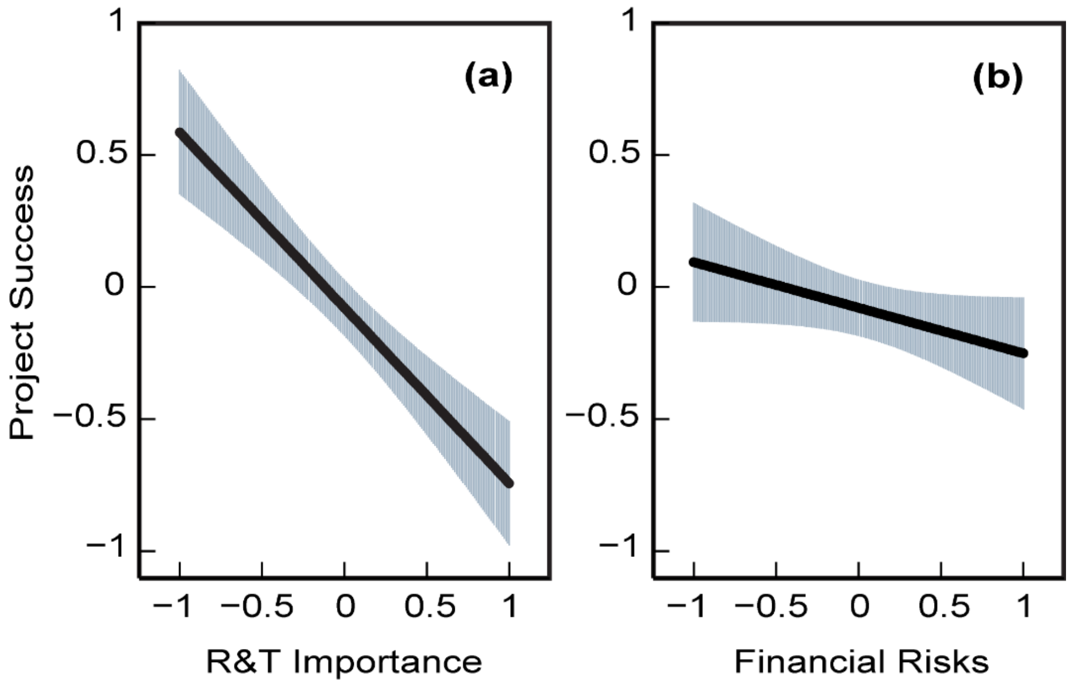


Figure 5.22: Project Success versus External and Internal Risks

The predicted dependences of the standardised project success score on the standardised scores for (a) R&T importance factor; and (b) financial risks factor, including the corresponding 95% prediction intervals. All categorical variables are assumed to be their zero categories and the remaining standardised numerical variables have zero values (which are close to their average standardised values).

The dependences shown in Figures 5.21 and 5.22 represent only the direct effects of the R&T importance and financial risks constructs on project success (see also Figure 5.20 and Table 5.12). The indirect and total effects of the involved constructs on project success have been quantified and discussed above in this section (see Equations 5.25–5.33).

The ‘good’ fit of Model 4 to the available data is demonstrated by the respective column with the GOF indices in Table 5.9 (including the CD value of around 65%). In addition, the ‘good’ agreement between Models 3 and 4 in parts that are common to them further demonstrates their mutual validity.

5.3.2.3 Project Success and Categorical Measures of Success (Model 5)

Items Q36 (‘The project was delivered on schedule?’) and Q37 (‘The project was delivered on budget?’) can be perceived as associated with the evaluation of project success. Both items are categorical variables with the two categories ‘Yes’ and ‘No’ (Appendix 4). Therefore, these variables cannot be reasonably included in the project success construct alongside the other four associated items (Q35 and Q38–Q40) that are considered numerical variables (Figure 5.2). Therefore, it is useful to establish any additional relationships between the two related categorical variables (Q36 and Q37) and project success.

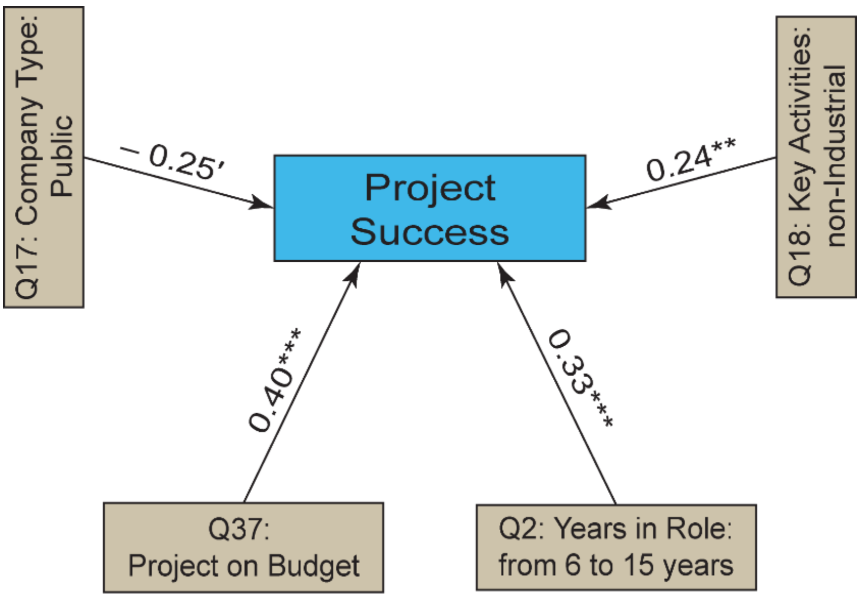


Figure 5.23: GSEM Model 5 – Project Success and Additional Variables

Figure 5.23 shows the GSEM model for the project success construct (Figure 5.2), including the additional categorical variables Q36 (‘The project was delivered on schedule?’ that is not significant) and Q37 (‘The project was delivered on budget?’), as well as the significant demographic and company variables (Q2, Q17 and Q18). Only significant (with $p < 0.1$) effects are shown in the model. Asterisks indicate the levels of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$; (′) $0.05 \leq p < 0.1$.

The GSEM analysis involving these two additional categorical variables and any significant demographic and company variables (Figure 5.23) shows that variable Q36 is not statistically significant ($p = 0.48$); thus, it has not been included in the model in Figure 5.23. Therefore, the participants did not perceive that whether the project was delivered on schedule was essential (significant) for the overall success of the project.

In contrast, the highly significant positive relationship between Q37 and project success (Figure 5.23) shows that whether a project is delivered on budget is highly important (highly significant) for the overall success of the project. The delivery of a construction project on budget improves the project success score by 0.40 compared with a situation in which the project is not delivered on budget (Figure 5.23).

Table 5.13: GSEM Model 5 – Project Success and Additional Variables

Response variable	**Predictor variables**	**Regression coefficient**	***p*-value**
Project success	Q2: Years in the job (from 6–15 years versus other)	0.33	< 0.001
	Q17: Company type (Public versus international, government and private)	–0.25	0.097
	Q18: Key company activities (Building, housing, infrastructure, other versus industrial)	0.24	0.002
	Q37: Project delivered on budget	0.40	< 0.001

Table 5.13 shows the outcomes of the GSEM model for the project success factor, the additional categorical variables Q36 (‘The project was delivered on schedule?’ that is not significant) and Q37 (‘The project was delivered on budget?’) as well as demographic and company variables Q2, Q17 and Q18, including the regression coefficients and their corresponding *p*-values.

The adjustment of the developed Model 5 for other significant demographic and company variables once again confirms the previously highlighted poor performance of publicly owned companies and the significantly better performance of companies with key types of activities other than industrial (see also Figures 5.18b and 5.21b).

As shown in Figures 5.17 and 5.20 and Tables 5.11 and 5.12, employees with 6–15 years' experience in the job perceive project success significantly more positively compared with employees with less than 5 years or greater than 16 years in the job (considered the zero category; Table 5.8). This variable has only indirect (positive) effects on project success in Models 3 and 4 through internal risks, external risks, communication and contract importance (Figures 5.17 and 5.20 and Tables 5.11 and 5.12).

This is consistent with Model 5, suggesting that employees with 6–15 years' experience have an average project success score that is 0.33 greater compared with all other employees (Figure 5.23 and Table 5.13). This finding is also consistent with the outcomes from Models 1 and 2 (Figures 5.12 and 5.14). Thus, all five models (Models 1–5) involving the RM practice outcomes factor, RM ratings and the project success factor corroborate each other's outcomes regarding the total effects of participants' work experience; that is, on their perceptions of project success or risk management success.

Table 5.9 demonstrates a perfect model fit for Model 5, although with a rather low CD value of 0.17. Thus, Model 5 can only explain around 17% of the total variance of project success. An explanation of the remaining 83% of the total variance of project success requires other variables and/or factors. This is expected, because the project success construct depends on a number of other variables and constructs (Figures 5.17 and 5.20). Model 5 is characterised by a low CD value because most of those variables and constructs are missing from this model (Figure 5.23), resulting in limited capability of Model 5 to explain the total variance of project success. Further, the perfect fit of this model (Table 5.9) shows the high relevance of Model 5 for the data, including the explanation of the relationship between Q37 and project success (Figure 5.23).

5.4 Discussion of the Findings

This section compares the main results and findings of this study with the existing literature reported in Chapter 2. The factor analyses and GSEM modelling of risk management in UAE construction companies represent a significant advancement in the current state of risk management research. The recent decades of the literature have seen significant research efforts aimed at identifying and characterising risks and optimum approaches to risk management in construction industries and projects around the world (Adams, 2008; Akintoye & MacLeod, 1997; Al Ariss & Guo, 2016; Dey, 2009; Enshassi *et al*., 2009; Grace, 2010; Kartam & Kartam, 2001; Kerur & Marshall, 2012; Mills, 2001; Ling & Hoi, 2006; Lyons & Skitmore, 2004; Oztas & Okman, 2004; Wang *et al*., 2004, 2016; Wibowo & Taufik, 2017; Zhi, 1995; Zou *et al*., 2007 and references therein; Ghahramanzadeh, 2013; Motaleb & Kishk, 2015), including in the UAE (Al Ariss & Guo, 2016; Al Mousli & El-Sayegh, 2016; Al-Sabah *et al*., 2014; El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Faridi & El-Sayegh, 2006; Khan, 2014; Ling *et al*., 2012; Motaleb & Kishk, 2010, 2013).

However, existing literature in risk management research still only represents the initial steps towards detailed analysis and rigorous modelling. This is because previous studies largely lacked comprehensive analysis, modelling and characterisation of existing risks. Many of the attempted quantitative characterisations of construction risks were based on limited mathematical approaches, such as several quantitative indices and coefficients and other basic statistical approaches for variable comparisons or ranking (Al-Hajj & Sayers, 2014; Al Harthi, 2015; Al Mousli & El-Sayegh, 2016; El-Sayegh, 2008, 2014; Enshassi *et al*., 2009; Kartam & Kartam, 2001; Lyons & Skitmore, 2004; Motaleb & Kishk, 2010; Odongo *et al*., 2012; Zou *et al*., 2007; for more detail, see Section 2.18).

Unfortunately, none of these studies or their outcomes can be used to indicate causal relationships (or effect paths) between different constructs associated with risks and their management in the construction industry. In addition to this, as described in Section 2.18, these methods have other significant deficiencies, including their inability to determine multiple and mutual effects of multiple survey-measured variables or adjust the outcomes for those variables. This significant drawback means that many of the previously used analytical approaches are prone to errors and uncertainties caused by numerous confounding effects. Further, none of the previously described methods for the analysis of risks in the construction industry could reasonably involve or be adjusted for any categorical demographic or company variables.

Recent research efforts have involved more advanced and better-justified statistical methodologies for the analysis of issues associated with the construction industry. These methodologies were based on CFA and SEM for the characterisation of potentially causal paths of effect between variables and/or factors (Demirkesen & Ozorhon, 2017; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Chandra, 2015; Gunduz *et al*., 2017; Khosvari *et al*., 2014; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Patel & Jha, 2016; Samee & Pongpeng, 2016; Sambasivan *et al*., 2017; Xiong *et al*., 2015).

A few of these papers focused on the identification and analysis of risks in the construction industry (Doloi *et al*., 2012; Chandra, 2015; Gunduz *et al*., 2017; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Patel & Jha, 2016; Samee & Pongpeng, 2016; Sambasivan *et al*., 2017; Wang *et al*., 2016). However, the body of literature on applications of SEM to risk identification and management is rather thin and none of the identified papers applied CFA and SEM to the analysis of risk management in the UAE construction industry. This demonstrates a significant gap in the existing knowledge (see Chapters 1 and 2) and highlights the significant contribution of the current study and its methodology and extensive findings, which are based on the consistent and well-justified use of advanced methodologies such as CFA and GSEM (the researcher found no studies that used GSEM for risk analysis and management).

Similarly, a limited number of studies have used Cronbach's alpha analysis to evaluate the internal consistency of risk factors and data (Altoryman, 2014; Demirkesen & Ozorhon, 2017; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Gunduz *et al*., 2017; Harvett, 2013; Low *et al*., 2015; Patel & Jha, 2016; Samee & Pongpeng, 2016; Wang *et al*., 2016; Xiong *et al*., 2015). However, these studies did not analyse the consistency of individual items associated with the proposed factor by removing the item from the factor and recalculating the Cronbach's alpha values (see Section 3.5.1.2 for more detail).

Therefore, it is argued that this study has made a significant step in the analytical determination and characterisation of risks and their management approaches in the UAE construction industry. The findings should be regarded as more reliable than the previous outcomes, as they were dully adjusted for the numerous factors and variables, including the categorical demographic and company variables. Potentially causal paths for the direct and indirect effects were identified and reliably characterised using one of the forefront statistical techniques based on GSEM and CFA.

The risk factors were developed using a variety of techniques (including EFA, Cronbach's alpha analysis and CFA) to achieve reliable cross-validation of the different techniques and to ensure sufficient statistical fits for all developed models. This type of comprehensive approach, which includes numerous cross-validations, has not been used in previous studies. It constitutes a substantial new contribution to existing knowledge regarding risks and their management approaches in the construction industry (specifically in the UAE).

The major findings are characterised by a degree of statistical elaboration and justification and are in general consistency with the previously obtained outcomes. A comparison of the risks with the previous literature findings might be difficult because of the diversity of the previous methods and outcomes (Khodeir & Mohamed, 2015; Musa *et al*., 2015) and, at times, their inconsistency with each other (including definitions and justifications). Nonetheless, there is general agreement with the previous findings when conducting a comparison with the previous literature. For example, the findings of the four most important risk factors (constructs), including external risks, communication, cultural diversity and R&T importance, are in general agreement with the previous findings of the following main risks:

- Political and social risks, the high cost of financing and exchange rates, and cultural differences (Ling & Hoi, 2006). These are consistent with the constructs of external risks, financial risks, cultural diversity and UAE culture. Similarly, findings by Ling *et al*. (2012)—that the procurement of materials, cultural diversity, communication, legal matters, human resources, schedule management and political issues are important for project success—are also in agreement with the outcomes of the current study.

- Contractual risks, issues with government approvals, poor work quality, injuries and safety, market and availability of workload, inadequate or incorrect project design, financial risks and difficulties, changing specifications and scope of the project, poor management, payment delays, poor planning and scheduling, ineffective decision-making and document design, and changes in laws and regulations (Akintoye & MacLeod, 1997; Al-Maamary *et al*., 2016; Altoryman, 2014; Babatunde & Perera, 2017; Perera *et al*., 2009; Pourrostam & Ismail, 2011; Tang *et al*., 2007) are generally consistent and agree with the constructs of contract importance (Figure 5.7), financial risks (Figure 5.6), internal risks (Figure 5.5) and external risks (Figure 5.4). The previously mentioned risks are also in partial agreement with the 10 most critical risks identified in the current study.

- Similarly, the outcomes obtained in this study are in general agreement with the findings of Ghahramanzadeh (2013) and Al Harthi (2015) (including risks such as changes and deficiencies of design, tight schedule, delays with materials, delays with approvals and unqualified staff). The four most important specific risks identified by Ghahramanzadeh (2013) are cash flow, inflation and interest rates, late payments and cost overrun. These are not fully consistent with the 10 most critical risks identified in the current study, and the differences may be attributed to the significantly advanced and better-justified statistical SEM methodology used in the current study.

- Significant differences in definitions of construction risks are considered in the current study and by Al-Hajj and Sayers (2014), Al Mousli and El-Sayegh (2016), El-Sayegh (2008, 2014), Biygautane (2017) and Toor and Ogunlana (2008). This makes direct comparisons quite difficult. The previous studies did not attempt factor analyses involving the identified specific risks. Therefore, they could not determine general trends associated with statistical constructs such as external risks (Figure 5.4), R&T importance (Figure 5.8), cultural diversity (Figure 5.10) and communication (Figure 5.11).
- The five most important risks identified by Al Mousli and El-Sayegh (2016)—lack of coordination inside the design firm, lack of a specialist construction manager, poorly written contracts, lack of project management as an individual professional service and time limitations in the design phase—are in general agreement with the findings of the current study and may be associated with constructs such as internal risks (Figure 5.5), communication (Figure 5.11) and contract importance (Figure 5.7).
- The 20 risks identified in international construction projects (Kerur & Marshall, 2012) are also in general consistency with the risk constructs developed in the current study and could mostly be regarded as variables associated with these constructs.
- Values and norms and literacy are identified as the most important cultural aspects for pricing (financial and contractual risks) (Odongo *et al*., 2012). They are in general agreement with the constructs of cultural diversity (one of the four most important risk factors) and UAE culture.
- Cultural diversity has previously been highlighted as an important risk that can affect HR management, communication matters and general management of the project (Kivrak *et al*., 2009; Zuo *et al*., 2012; Wu *et al*., 2017). This is consistent with the finding of the current study that cultural diversity (Figure 5.10) is one of the four most important risk factors in the UAE construction industry.

As indicated above, any observed differences in the findings of the literature sources and the current study may be a result of either differences in the definitions of the risks or the more advanced and better justified statistical (quantitative) SEM methodology used in the current study.

Some studies that have used SEM and factor analysis of risks in the construction industry (Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Chandra, 2015; Gunduz *et al*., 2017; Khosvari *et* *al*., 2014; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Patel & Jha, 2016; Samee & Pongpeng, 2016; Sambasivan *et al*., 2017) have significant methodological deficiencies such as an insufficiently justified model fit (Kim *et al*., 2009; Liu *et al*., 2016), do not consider possible effects between the developed risk factors/constructs (Chandra, 2015; Gunduz *et al*., 2017; Low *et al*., 2015) or they involve survey questions and constructs that are significantly different from those in the current study (Chandra, 2015; Eybpoosh *et al*., 2011; Doloi *et al*., 2012; Sambasivan *et al*., 2017). This makes it difficult to compare the outcomes of the current study with previous findings in this regard.

Kim *et al*. (2009) found that the most important factors (with the largest total effects on project performance) were the attitude and ability of owners, the commitment of the organisation, project information at an early stage, appropriateness of cost management and quality of estimation. These factors are in general agreement with the constructs developed in the current study, including external risks (Figure 5.4), internal risks (Figure 5.5), communication (Figure 5.11), contract importance (Figure 5.7), R&T importance (Figure 5.8) and financial risks (Figure 5.6). Any differences may be attributed to the different risk definitions and groupings into factors by Kim *et al*. (2009), lack of adjustments for demographic and company categorical variables and potentially insufficient model fit.

Gunduz *et al*. (2017) and Low *et al*. (2015) considered two-factor models to characterise two different levels of the developed constructs. The first-level constructs were associated with (grouped into) constructs of the second level. The second-level constructs included, for example, economic risks and political risks (Low *et al*., 2015). It is difficult to compare the outcomes of these two papers with the findings of the current study because the indicated papers did not consider the effects of the developed risk constructs on the success of construction projects, and their constructs were significantly different in nature from those developed in the current study.

Eybpoosh *et al*. (2011), Doloi *et al*. (2012) and Sambasivan *et al*. (2017) presented better justified studies involving SEM and construct development using CFA and Cronbach's alpha analysis. However, these studies used the dependent constructs of cost overrun (Eybpoosh *et al*., 2011; Sambasivan *et al*., 2017), abandonment (Sambasivan *et al*., 2017) and construction delays (Doloi *et al*., 2012). As these constructs form only parts of the overall construct of project success (Figure 5.2), the outcomes cannot be directly and comprehensively compared with those obtained in the current study (because of the more general nature of the dependent variables in the current study). Sambasivan *et al.'s* (2017) findings that the 'external' and ‘material’ constructs have major effects on ‘cost overrun’ and ‘abandonment’ are consistent with the findings of the current study that external risks and R&T importance are two of the four most important factors for project success.

Similarly, the most important risk factors (with the largest total effects) identified by Eybpoosh *et al.* (2011) included contractors’ lack of resources (total effect of 0.565), contractors’ lack of managerial skills (total effect of 0.275) and adverse change in site conditions (total effect of 0.267). These loosely correspond to two constructs in the current study: R&T importance (total effect of −0.58; Figure 5.20) and internal risks (total effects of −0.12 to −0.17; Figures 5.17 and 5.20). The difference in signs of the total effects is caused by the opposite nature of the dependent variables considered by Eybpoosh *et al*. (2011) (cost overrun) and in the current study (project success).

Any further differences may be attributed to the different natures of the dependent variables (see Section 5.2.1), different foci of the surveys and groupings of the survey items into factors and adjustment of the outcomes in the current study for demographic and company categorical variables (Figures 5.17 and 5.20).

5.5 Conclusion

The quantitative outcomes obtained in this chapter are based on an appropriate framework of advanced statistical methods (EFA, Cronbach’s alpha analysis, CFA, SEM and GSEM) for the development and characterisation of statistical constructs and the determination of paths of causal effects between them. For the first time, the analysis of risks, their effects and effect paths were statistically adjusted for the demographic and company variables. Therefore, the resultant outcomes and findings (based on this advanced methodology) constitute a significant advancement in the existing knowledge regarding risk identification and characterisation in the UAE construction industry and in the more general context of broader construction industries.

Unexpectedly, risk-averse companies were strongly and positively associated with perceived difficulties in identifying, assessing and managing risks in the UAE construction industry. This has led to a conclusion that risk-averse UAE construction companies are, on average, overcautious in their attempts to avoid any risks, which could be detrimental to their business. A better approach is to identify, face and manage risks in a reasonable and calculated way. It is possible that this finding has broader implications outside of the UAE context. However, confirmation or otherwise of this expectation will require further research in this area.

The only identified cultural aspect that is significantly beneficial for the success of construction projects and risk management in the UAE is the more stringent attitude towards time compared with many Western countries. All other cultural aspects, including the preference to conduct business face to face, preferred prior personal knowledge of a business partner and strong vertical hierarchy of most Emirate companies, are detrimental to the success of projects and risk management in the UAE construction industry. Significant cultural diversity of the UAE workforce is a major factor that is perceived as detrimental to project success. The only possible exclusion from this trend is the diversity of education backgrounds, which is likely to have a positive (albeit rather weak) effect on project success.

The four most critical risk factors (constructs) have been identified and characterised as external risks, communication, cultural diversity and R&T importance. In their efforts to manage and alleviate risks, companies ought to provide priority to risks from these four constructs. A number of other findings and recommendations have also been derived from the statistical analyses and modelling (see the discussions of the developed GSEM and CFA models in this chapter and in Chapter 7).

The outcomes are in general agreement with the previous literature findings. However, the outcomes obtained in this study are based on significantly different, sound and well-justified mathematical and statistical procedures. Thus, these outcomes are systematic, reliable and informative in relation to the quantitative characterisation of the obtained effects and any causal influences of the variables and factors on each other and on the success of construction projects.

Chapter 6 is a continuation of analysis, results and findings as done in this chapter. However, the chapter explores the qualitative data collected via interviews conducted with selected UAE participants. The chapter will discuss and cross-reference this chapter to highlight the similarities and differences in terms of the results and findings regarding the risks involved in the UAE construction projects. Finally, the chapter will explain the findings from the interviews and compares them with findings from the literature.

Chapter 6: Results and Discussion of Qualitative Data

6.1 Introduction

Chapter 5 discussed the major quantitative outcomes of the statistical modelling of the survey data, including the description and interpretation of the major identified statistical constructs associated with risk management in UAE construction projects and comparisons with the previous literature findings.

This chapter describes the major outcomes of the coding and qualitative analysis of the 13 semi-structured interviews that were conducted with sufficiently qualified self-selected study participants. As described in Section 3.6, the final selection of the interview participants was conducted based on reasonable representation of all three participant categories (clients, contractors and consultants) and sufficient experience of the interviewees in the UAE construction industry. This selection enabled expert opinions and propositions in relation to existing risks and their management approaches in the UAE construction industry. This chapter also explains the findings from the interviews and compares them with findings from the literature.

The qualitative analysis was conducted using the NVivo 11 software package, including the development of themes and codes associated with existing risks and their management practices in the UAE construction industry. Comparisons with the previously described quantitative outcomes were also conducted to further corroborate the outcomes and check for completeness of identification and coverage of the significant and important risk factors. Quotations and coding schemes are shown for each participant, followed by the interviewee's ID in brackets.

6.2 NVivo Outcomes

6.2.1 Preliminary Findings

As mentioned in the description of the methodology in Chapter 3, all participants had to be at a senior management level in their organisations to make reasonable judgements on the risks associated with construction projects and the strategies and/or mitigating factors used to manage and alleviate those risks. Therefore, only high and middle-level managerial and technical engineering staff were eligible to take part in this study.

Thirteen semi-structured interviews were conducted, including two clients (15.4%), six consultants (46.1%) and five contractors (38.5%). The distribution of the interviewees therefore appeared somewhat different from that of the clients (13.9%), consultants (23.6%) and contractors (62.5%) in the overall sample of participants for the quantitative analysis (Figure 4.1a). However, this was not seen as a major issue for the qualitative analysis and comparison of its outcomes with the quantitative findings because representatives of all categories of participants took part in the interviews and the participation differences were considered sufficient for an expectation of any significant bias of the qualitative outcomes compared with the quantitative findings.

Question 2 of the semi-structured interview provided additional useful insights into the nature and characteristics of the interviewees and typical construction projects with which they were involved. For contractors, their typical extent of involvement in construction was between around $800 million (Interviewee 2) and around $12 billion (Interviewee 9), with the greatest focus on civil engineering construction such as hotels, houses, bridges, office complexes, buildings, shopping malls, stadiums, research facilities and skyscrapers. One contractor (Interviewee 5) was more focused on local road projects and information technology services (ITS), including communication and information processing around expressways. The two client interviewees worked for designer companies, including large construction projects such as hotels, residential apartments, residential buildings, commercial buildings and a conference centre. The six interviewed consultants were also mostly involved in large civil engineering and infrastructure projects. Interviewees 10 and 12 indicated significant involvement in oil and gas industries, with Interviewee 12 mostly specialising in this area of construction.

Codes and themes relevant to risks and their management strategies in the construction industry were developed, including the determination of the frequencies of each identified code. Appendix 8 presents the word tree developed using NVivo. It shows the words and expressions typically used in conjunction with the words 'risk management'. Larger font sizes indicate higher frequencies for the respective words or expressions.

As shown in the word tree, the interviews were diverse in terms of the 'words' used by the interviewees. In addition, the typical frequencies for the words and expressions appearing together with the words 'risk management' are similar, as shown by the similar font size for different words and expressions. This means that different interviewees used different words and expressions together with the words 'risk management' when discussing risks and their management approaches in the construction industry. The diversity of wordings used by the participants during their interviews was the reason for the diversity of codes used to describe the interviews, which resulted in relatively low frequencies for most of the codes.

Figure 6.1 shows the word cloud as another means of visualising the frequencies of different words associated with the characteristic word ‘risk’, reflecting risks and their management approaches in the UAE construction industry. The most frequently used words by interviewees were ‘cultural’, ‘contract’, ‘economic’, ‘communication’, ‘resources’, ‘strategies’ and ‘plans’. This indicates the importance of these words and what they represent for the topic of the interviews. Importantly, this is consistent with the quantitative findings in Chapter 5, which noted that factors such as contract importance, R&T importance, UAE culture, cultural diversity, communication, internal risks and financial risks were significant and important for project success (see Figures 5.17 and 5.20).

Figure 6.1: Word Cloud

The word cloud in Figure 6.1 identifies and illustrates the most frequently occurring words in the available interview data in association with the word ‘risk’. The observed frequencies range between 1001 (for the word ‘risk’) and 42 for the words with the smallest font.

6.2.2 Risk Groups

The NVivo coding was developed using the preliminary findings described in the previous section. For example, based on the diverse wordings used by the interviewees (Appendix 8), the expected coding nodes and sub-nodes were not expected to have large frequencies of repetition in different interviews. It was therefore necessary to consider coding nodes that may have relatively small frequencies and link them to more general concepts that might be associated with the quantitative risk factors identified (Chapter 5). Therefore, the coding was guided by the previously considered quantitative risk factors. This approach enabled sensible comparisons to be made between the qualitative codes and quantitative factors/findings.

More particularly, special attention was paid to identifying risks or concerns that were not directly associated with the quantitative factors considered in Chapter 5. This was important because one of the objectives of the qualitative analysis was to verify the completeness of the quantitative factors and outcomes obtained and characterised in Chapter 5. Therefore, the coding and analysis also focused on identifying any additional risk-related factors in the UAE construction industry that might not have been identified and characterised in Chapter 5.

6.2.2.1 Cultural Risks Group

It was expected that cultural matters would significantly contribute to risk management approaches in the UAE construction industry. This was supported by the fact that the cultural diversity risk factor had one of the strongest total effects on project success (see Figure 5.17 and Equation 5.20b) in Chapter 5. This motivated the commencement of the qualitative analysis starting from the consideration of risks associated with cultural issues in the UAE.

Question 11 of the semi-structured interviews asked participants whether they perceived economic and cultural factors as having a significant effect in the UAE and to elaborate on the major strategies for dealing with these risk factors. The frequency analysis of the interview data demonstrated that five consultants, five contractors and one client (11 of 13, or 85% of all interviewees) regarded the factors associated with cultural and economic matters to have a significant effect on UAE construction projects. There is high consistency and thus increases the validity of this conclusion. It also corroborates the similar quantitative findings in Chapter 5.

Table 6.1: UAE Culture Nodes

Construct	Nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
UAE culture	Changing requirements without considering consequences	0	0	1 (16.67%)	1 (7.69%)
	Vertical hierarchy structure	1 (50%)	3 (60%)	3 (50%)	7 (53.85%)
	Risk management knowledge in Emirates	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Start project and worry about problems later	1 (50%)	0	0	1 (7.69%)
	Trust	0	2 (40%)	1 (16.67%)	3 (23.08%)
	Risk avoidance or overlooking	1 (50%)	0	1 (16.67%)	2 (15.38%)

Table 6.1 shows the nodes and sub-nodes developed for the construct of UAE culture and other groups, including their frequencies and category-relevant percentages of responses. Appendix 8 provides an extract from NVivo, which shows some of the nodes, sub-nodes and their respective frequencies.

Table 6.1 shows the outcomes of the qualitative analysis in relation to the nodes identified in association with the UAE culture construct. Nine interviewees mentioned UAE culture 27 times in their responses, which highlights the importance of this construct for risk management and project success. Further, the vertical hierarchy of the organisational structure was identified as the most relevant (and potentially exacerbating other cultural risks) aspect of the UAE culture construct (Table 6.1):

> *"I think cultural factors may be further influenced by Emirates companies being of a vertical hierarchy structure."* (Interviewee 1, consultant)

Other participants largely expressed similar views that vertical hierarchy organisational structure was a factor influencing project success:

> *"There is a strong vertical hierarchy structure in our organisation in Dubai."* (Interviewee 2, contractor)

> *"From my point of view, cultural differences between . . . stakeholders . . . affect . . . the projects."* (Interviewee 3, contractor)

> "C*ultural things I think is a big factor because there are many nationalities in UAE."* (Interviewee 6, client)

Based on the interview results, the % total was calculated for each risk based on the sum of 3 participants. The NVivo nodes mentioned by more than 20% of the interviewees deserved special attention based on their prevalence. In this case, a 20% identification threshold was chosen to limit the number of specific risks to be considered in this study in greater detail.

The second important node within UAE culture was trust (Table 6.1). The interviewees found it difficult to gain the trust of local clients, and this was an important issue for the success of construction projects:

> *"My recommendation is for those who aim to start business in the UAE for the first time that they must work in the existing UAE firms. . .. It is challenging [to] gain trust from local clients."* (Interviewee 9, contractor)

The issue of trust was mentioned by three interviewees and was one of the specific cultural risks identified by the participants. Therefore, trust-related issues should be considered a potential risk capable of significantly affecting project success in the UAE construction industry. However, because trust-related risks were not included in the survey instrument and were not subjected to the quantitative analyses, any such risks at this stage were only regarded as potential. Their quantitative analysis is a matter for future research. The same will also apply to any other qualitative findings in this chapter, which will be identified in addition to the quantitative outcomes in Chapter 5.

The other construct that is directly relevant to cultural matters and risk factors is cultural diversity (Table 6.2). This construct is different from UAE culture because it reflects differences between individuals from different cultures and customs who work on the same project and, at times, for the same construction company.

Table 6.2: Cultural Diversity Nodes

Construct	Nodes	Sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Cultural diversity	Cultural and custom differences		1 (50%)	0	2 (33.33%)	3 (23.08%)
	Different languages		2 (100%)	3 (60%)	4 (66.67%)	9 (69.23%)
	Different dispute resolutions		0	0	1 (16.67%)	1 (7.69%)
	Decision making processes	Different decision-making processes	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)

Table 6.2: Cultural Diversity Nodes Continued

Construct	Nodes	Sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
		Poor experience in decision-making processes	0	1 (20%)	1 (16.67%)	2 (15.38%)
Cultural diversity	Different ways of thinking		0	1 (20%)	0	1 (7.69%)
	Many of expatriate workers		1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Emiratisation process		0	0	2 (33.33%)	2 (15.38%)
	High turnover of employment		0	0	1 (16.67%)	1 (7.69%)

Table 6.2 shows the nodes and sub-nodes developed for the construct of cultural diversity, including their frequencies and category-relevant percentages of responses. Appendix 8 provides an extract from NVivo, which shows some of the nodes, sub-nodes and their respective frequencies.

The most frequently mentioned risk associated with cultural diversity is different languages (Table 6.2). This is consistent with the largest factor loading for item Q31.14 (Appendix 4) associated with different languages in the cultural diversity construct (Figure 5.10):

> *"We have heard that the number of different languages spoken on a site and the literacy of the workers have been a barrier . . . on many construction projects."* (Interviewee 10, consultant)
>
> *"A significant cultural barrier I frequently encounter is the language barrier."* (Interviewee 7, consultant)
>
> *"Progressing projects are usually hindered by imperfect or unclear communication as per the existing language barriers."* (Interviewee 8, client)

The other three nodes above the 20% identification threshold are cultural and custom differences (23.08%), different decision-making processes (30.77%) and many expatriate workers (30.77%) (Table 6.2). The first of these nodes is general and does not address any specific cultural differences. Therefore, the high frequency of this node is regarded as the general corroboration of importance of the cultural diversity construct. This is consistent with the previous quantitative outcomes (see Figure 5.10).

The node of different decision-making processes (30.77%) appears to be consistent with item Q31.17 (Appendix 4). The high frequency of this node corroborates the previous quantitative finding of the large factor loading for Q37.17 (see Figure 5.10).

The node of many expatriate workers (30.77%) is not included in the developed survey measurement instrument (Appendix 4). The emergence of this node in the qualitative analysis suggests that future research should investigate any relationships between the presence of large numbers of expatriate workers and potential construction risks and/or risk management strategies. The interviewees gave somewhat conflicting statements in relation to this matter. One interviewee suggested that:

> *"The drive to replace expatriates with skilled Emiratis has been in progress for many years. In some areas . . . the pace has quickened recently. My personal view is that this is a very good thing for the country."* (Interviewee 10, consultant)

Other interviewees saw the large number of expatriate workers as a positive aspect that enabled more qualified workers to be hired:

> *"We got a lot of our best talent from expatriates."* (Interviewee 2, contractor)
>
> *Because our company relies heavily on expatriates, we are competing for skilled staff with other companies."* (Interviewee 9, contractor)

This demonstrates a potentially wide spectrum of opinions on expatriate workers in the UAE construction industry. Unfortunately, it does not allow for the reliable identification of potential risks associated with the large number of expatriate workers (apart from and in addition to the discussed risks associated with different languages, levels of education, culture and customs). Therefore, although the issue of large numbers of expatriate workers was frequently raised in the context of qualitative analysis (Table 6.2), further research is required to reliably establish whether any risks in the construction industry are associated with this issue, or whether it is a largely beneficial aspect that could be considered a reasonable tool for the management and alleviation of existing risks.

Cultural diversity risks are also involved in the external risks construct (Table 6.3). The association of these risks with the external risks construct was made because the risks were considered external to companies: similar to how item Q29.13 was regarded as an external risk in the quantitative external risks construct (Figure 5.4). On this basis, the following cultural nodes (cultural external risks) are associated with the external risks construct: cultural differences (46.15% response rate), different education (38.46%), different values (30.77%)

and work culture (30.77%). Cultural external risks are again among the highest-ranked risks within the external risks construct. This further confirms the widely recognised importance of cultural risks for the UAE construction industry.

Table 6.3: External Risk Nodes

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
External risks	Corruption	0	2 (40%)	1 (16.67%)	3 (23.08%)
	Market demands	1 (50%)	3 (60%)	2 (33.33%)	6 (46.15%)
	Law changes	0	2 (40%)	0	2 (15.38%)
	Cultural differences	0	3 (60%)	3 (50%)	6 (46.15%)
	Different education	0	4 (80%)	1 (16.67%)	5 (38.46%)
	Knowledge	0	3 (60%)	1 (16.67%)	4 (30.77%)
	Experience	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Lack of qualified experts and knowledge	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Lack of experience on similar projects	0	1 (20%)	0	1 (7.69%)
	Different values	0	4 (80%)	0	4 (30.77%)
	Work culture	0	4 (80%)	0	4 (30.77%)
	Short notice economic changes	0	0	1 (16.67%)	1 (7.69%)
	Oil price	0	3 (60%)	1 (16.67%)	4 (30.77%)
	Increased competition for talent from other countries	0	1 (20%)	0	1 (7.69%)
	Global financial crisis	1 (50%)	0	0	1 (7.69%)
	Political and social stability	0	1 (20%)	2 (33.33%)	3 (23.08%)

Table 6.3 shows the nodes and sub-nodes developed for the construct of external risks, including their frequencies and category-relevant percentages of responses (see Appendix 8).

Some examples of the interviewees' specific comments relating to these four external cultural risks are presented above and as follows:

> *"Foreign workers in Emirates need* [to] *understand* [and] *respect local culture. . .. They need to understand the cultural impact exerted by the stakeholders on the scope and project management."* (Interviewee 1, consultant)

> *"The other major risk is economic and different cultural factors, because these factors . . .impact on the construction projects in the UAE . . . market demand, inflation . . . exchange rate."* (Interviewee 4, contractor)

Interviewees 2 (contractor), 3 (contractor), 4 (contractor) and 11 (consultant) listed cultural and educational issues and differences as the number one or number two risk among the 20 identified risks (see Table 6.3). This demonstrates that contractors are particularly concerned about cultural risks. It can be argued that such risks are likely to be most critical on construction sites and in dealings between contractors and other stakeholders. The critical risk of project failure is related to poor interactions between employees on site (which should be regarded as internal rather than external risks) and between project stakeholders involving contractors (which can be qualified as internal and external risks). According to the observations and judging by their more widespread concerns, contractors are more likely to be concerned about and suffer more from the existing cultural and educational issues and differences.

It appears that the clients were least concerned about cultural matters in relation to external risks (Table 6.3). This is probably because they are least involved in the construction process and are therefore the least susceptible to cultural risks. However, it is still not possible to say for certain that clients are the least concerned about cultural risks, with Tables 6.1 and 6.2 presenting clients' response rates in relation to these issues. In addition to this, because of the small number of clients (two) involved in the interviews, the qualitative outcomes may be biased and cannot be regarded as reliable. This is further confirmed by the absence of any significant quantitative links between the three categories of participants and cultural risks (Figure 5.17).

To conclude this section, it is useful to note the following comment made by Interviewee 5 (contractor): "*There was a lot of willingness to say yes* [to the presence of cultural differences], *but not really a willingness to actually understand fully exactly what everyone was talking about so that they could progress properly.*" This demonstrates the current lack of progress towards a detailed understanding of the effects and mechanisms of the risks associated with cultural diversity and other cultural aspects, including optimal ways to deal with these issues and risks in the context of the UAE construction industry. One of the objectives of this thesis is to fill these gaps and provide a better understanding of the major cultural effects on the success of construction projects (see Section 5.2.2.8 and the qualitative analysis 6.2.2.1 in this chapter).

6.2.2.2 Economic Risks

The other major group of risks is related to economic issues. The interviewees identified several economic risks associated with different perceived constructs. For example, external risks are associated with several economic risks, including market demand, short-notice economic change, oil prices and the global financial crisis (Table 6.4). The risks exceeding the 20% identification threshold are market demand (46.15%) and oil prices (30.77%).

Interviewees' typical comments regarding the major external economic risks were as follows:

> *"Because of such factors as the price of oil, from my understanding the economic market in the UAE plays an important role."* (Interviewee 2, contractor)

In response to the question 'Do you think, in your opinion, the oil price was affecting the construction projects in the UAE?', Interviewee 5 (contractor) replied: "*Very much.*"

Thus, it is apparent that the dependence of Middle Eastern economies on oil and oil prices (including in the UAE) has a major effect on the overall economic performance of these countries and their industries, including the construction industry. The oil prices can have a drastic effect on market demand, thus introducing significant risks that might not be as prevalent in other parts of the world. Alleviation of this dependence on oil prices is regarded as a priority for Middle Eastern countries, including the UAE. Oil prices are important because they affect clients' capacity to invest, or even worse, can create 'stop-start' capital flows that lead to time and cost problem, i.e., budget cuts.

Table 6.4: Financial Risk Nodes

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Financial risks	Foreign exchange	2 (100%)	3 (60%)	4 (66.67%)	9 (69.23%)
	Inflation	1 (50%)	4 (80%)	4 (66.67%)	9 (69.23%)
	Interest rates	2 (100%)	1 (20%)	2 (33.33%)	5 (38.46%)
	Budget issues	2 (100%)	4 (80%)	1 (16.67%)	7 (53.85%)
	Cost overrun	0	4 (80%)	2 (33.33%)	6 (46.15%)
	Increased (or changed) prices of materials and rates	1 (50%)	3 (60%)	1 (16.67%)	5 (38.46%)
	Lack of financial resources	1 (50%)	1 (20%)	4 (66.67%)	6 (46.15%)
	Financial difficulties - client, owner, contractor	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Late payments by client	0	2 (40%)	2 (33.33%)	4 (30.77%)

Financial risks constitute part of the group of risks related to economic issues (Table 6.4). The most prominent and prevalent financial risks exceeding the 20% identification threshold are foreign exchange (69.23%), inflation (69.23%), budget issues (53.85%), cost overrun (46.15%), lack of financial resources (46.15%), interest rates (38.46%), increased (or changed) prices of materials and rates (38.46%) and late payments by clients (30.77%).

The node of budget issues (Table 6.4) is a general formulation of the risks associated with budget issues and it reflects the recognised need to construct the budget thoughtfully and reliably:

> *"The third one I would like to put in the third position is when we get unexpected budget cuts, which is actually more appropriate in the Middle East or UAE."* (Interviewee 1, consultant)

Most of the budget issues were related to cost overrun, with six out of seven interviewees mentioning budget issues as a significant risk factor and focusing on cost overrun:

> *"One* [of the priorities] *is often the time and the cost estimate as being too optimistic."* (Interviewee 1, consultant)

Interviewees also mentioned other high-priority economic and/or financial risks:

> *"I believe unstable economic leading to increase the price of materials and equipment . . . labour supply . . . cash flow problems faced by clients . . . and late payment from the client's side."* (Interviewee 10, consultant)

> *"I think fluctuations in currency exchange rates* [as the first priority risk].*"* (Interviewee 3, contractor)

> *"Economic factors that usually affect the smooth running of our projects include sudden changes in price . . . shortages of equipment . . . shortages of manpower and scarcity of materials."* (Interviewee 4, contractor)

The node of budget issues identified by the interviewees is too general and is not directly reflected in the quantitative analysis (Chapter 5). However, other risks, including inflation and interest rates, currency exchange, cash flow and late payments by clients, are directly considered and quantified in Chapter 5 (Figure 5.6). This demonstrates close agreement between the qualitative and quantitative analyses and their outcomes.

A separate financial issue commonly identified by the interviewees is the financing of construction projects, with one node overcoming the 20% identification threshold (government-approved financing, with a 38.46% identification rate):

> *"It could be good to say that* [projects] *are financed or approved at government level in the UAE."* (Interviewee 1, consultant)
>
> *"Small public projects are usually funded by the government."* (Interviewee 4, contractor)
>
> *"All the ones that I was involved with were government financed so it was all work for different government agencies."* (Interviewee 5, contractor)
>
> *"A lot of* [projects] *are financed just outright just by the government but we are talking in Abu Dhabi here where it is oil cash flow there."* (Interviewee 6, client)

This demonstrates significant dependence of the UAE construction industry on government finances, grants and orders. The interviewees did not identify any risks associated with this form of dominant financial sources within the industry. Thus, no such risks were involved in the previous quantitative analysis. However, this financial factor creates potential risks associated with the government's ability to provide the required funding and live up to the industry's expectations in terms of being its significant financial resource. Government funding in the UAE is highly reliant upon oil prices and trends in the fossil fuel market.

Although significant efforts have been made recently to deviate from this dependency, the reality must be considered. The result is financial risks associated with oil prices, inflation, regional stability and currency exchange rates (as discussed above). Further research is required into potential risks associated primarily with the government financial sources for the UAE construction industry. This factor may represent a distinction between the construction industries in the UAE and Western developed countries, which have more diverse financial sources (including private sources) for construction projects.

It appears that the UAE government should diversify financial sources for the construction industry to reduce the risks and shortcomings of having mainly government financing. The Organisation for Economic Co-operation and Development (OECD) discussed methods for boosting private investors' contributions in its report entitled *Private Financing and Government Support to Promote Long-Term Investments in Infrastructure* (2014, p. 6). The most important factors for stimulating private investors in the construction and infrastructure industries are identified as "*a clear institutional framework, transparent bidding and awarding procedures, a robust rule of law, and the absence of political interference*" (OECD, 2014, p. 11).

The last sub-group of risks associated with the group of economic risks is R&T risks (Table 6.5). Interviewees identified the lack of availability of resources as the most prevalent risk (53.85% identification rate). Delays in accessing resources were not common among the interviewees. Scarcity of materials was the most frequently specified risk (23.08% identification rate) within the node of 'lack of availability of resources'.

The most important aspect of the R&T risk group is the lack of commitment by suppliers to provide resources as per the initial plan and/or agreement (see the extracts from the interviews above in this section). One interviewee added to that:

> *"The next one I would put down is lack of resource commitment . . .. It's important to accept* [this] *will always be a risk."* (Interviewee 1, consultant)

Table 6.5: Resources and Technology Risk Nodes

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Resources and technology	Lack of availability of resources	1 (50%)	3 (60%)	3 (50%)	7 (53.85%)
	Delays in access to resources	1 (50%)	1 (20%)	0	2 (15.38%)

In addition to this, Interviewees 2 (contractor), 4 (contractor), 8 (client), 9 (contractor), 11 (consultant) and 13 (consultant) mentioned the availability (shortage) of materials, equipment and components as one of the major risks for the success of construction projects.

Several questionnaire items that reflected specific risks associated with R&T were included in the quantitative analysis (Figure 5.8). The high response rate in relation to materials and resources as significant risks (Table 6.5) is consistent with the quantitative finding that the construct of R&T importance is significant for project success (Figure 5.20). In fact, the R&T importance construct had the largest total effect on project success in Model 4 (see Equation 5.33d).

6.2.2.3 Labour-related Risks

Labour-related risks are included in several groups of risks emerging from the qualitative analysis. For example, the cultural diversity group (Table 6.2) involves several risks that can be associated with individual employees; for example, the risks associated with different languages and many expatriate workers (these risks are considered in detail in discussions of the cultural diversity group of risks in Section 6.2.2.1).

Similarly, the external risks group (Table. 6.3) involved several labour-related risks, such as different education, knowledge, experience, lack of qualified experts and knowledge. Those that exceeded the 20% identification threshold were different education (38.46%), knowledge (30.77%) and lack of qualified experts and knowledge (38.46%). The relevant extracts from different interviews were presented in Sections 6.2.2.1 and 6.2.2.2 and are as follows:

> *"In my experiences in UAE for 17 years. . .. Emirates contractors partially lack risk management knowledge and expertise."* (Interviewee 1, consultant)
>
> *"A principal risk factor is . . . risk management experience or competence* [such as having a] *different education background."* (Interviewee 2, contractor)
>
> *"Lack of qualified staff in contractor's organisation*. (Interviewee 3, contractor)
>
> *Employees and clients' managers are not skilled . . . not qualified experts."* (Interviewee 9, contractor)

As shown, numerous comments focused on the lack of labour and managerial skills, experience and competence. Therefore, this can be regarded as one of the major issues for adequate risk management in the UAE construction industry.

Table 6.6: Internal Risk Nodes

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Internal risks	Human resources	0	2 (40%)	2 (33.33%)	4 (30.77%)
	Site safety - poor supervision and practices	0	3 (60%)	3 (50%)	6 (46.15%)
	Inadequate project management	0	0	1 (16.67%)	1 (7.69%)
	Effects of internal risks	0	0	0	0
	Labour supply	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Inadequate quality control	0	2 (40%)	2 (33.33%)	4 (30.77%)
	Delays in mobilising suitable workforce	0	0	2 (33.33%)	2 (15.38%)
	Interaction with other projects nearby	0	0	1 (16.67%)	1 (7.69%)
	Lack of compliance with safety and risk management processes	0	1 (20%)	0	1 (7.69%)

Managerial risks are also relevant (at least in part) to labour-related issues because they are relevant to managers as employees of contractor and consulting companies. They are presented separately in Table 6.6. The managerial risks are also largely associated with the previously developed and considered quantitative construct of internal risks (Figure 5.5). As shown, interviewees identified four different internal risks/issues at a level above the 20% identification threshold: HR (30.77%), site safety–poor supervision and practices (46.15%), labour supply (30.77%) and inadequate quality control (30.77%). Some relevant quotes related to this are as follows:

> *"Another risk is the HR plan. The HR is there to support the project in terms of resources, et cetera. But, my view of HR . . .. Their workload is mainly driven by the performance of a project team. If a project team get everything right, first time and every time, the HR can go back to sleep. . .. I see the HR as necessary follow-up basis, to follow up risks, in case some of the risks missed by the team."* (Interviewee 1, consultant)

> *"Unstable economic leading to* [problems with] *labour supply. . .. Inadequate quality control, leading to additional rework and delay. . .. Poor safety supervision."* (Interviewee 10, consultant)

> *"We are making sure that everyone is safe. ... Sometimes see some failings in parts, where there are manholes and stuff uncovered, definitely a problem. … Accidents happen at times on construction sites."* (Interviewee 13, consultant)

Apart from inadequate quality control, the remaining three identified risks are consistent with the survey items used for the internal risks construct (Figure 5.5). Inadequate quality control may be another significant item that should be included in future in the internal risks construct. Thus, the qualitative analysis again demonstrated its usefulness in terms of identifying additional potential risks that might have slipped through the net of the quantitative research undertaken in the current study and by other research groups in this area (particularly in the context of the UAE construction industry).

6.2.2.4 Communication Risks

Interviewees widely recognised communication as a major risk in the UAE construction industry (Table 6.7).

Table 6.7: Communication Nodes

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Communication risks	Communication risks between different parties	2 (100%)	5 (100%)	4 (66.67%)	11 (84.62%)
	Quiet approach to handling problems	0	1	0	1

The main communication-related risk identified by interviewees was poor communication between different parties to the project (84.62% identification rate). This is the highest identification rate obtained from the interviewees so far, thereby demonstrating the perceived importance of this issue for the development of risk management strategies in the UAE construction industry. Moreover, the clients and contractors interviewed were particularly concerned about the communication risk, with all interviewees in these two categories identifying this risk as important for project success and risk management (Table 6.7):

> *"Customer review and feedback is too slow, receive the feedback out of date or it's out of time it's ineffective. . .. Let's just call it, a lack of clarity and understanding of the stakeholders' needs. You might call it communication. . .. If the communication is less adequate, then* [it] *causes misunderstandings and delays. . .. communication maybe should be a higher priority."* (Interviewee 1, consultant)

> *"Communication or cultural differences is the real risk there."* (Interviewee 5, contractor)

> *"Communication between consultant staff . . . contractors . . . communicate using their native tongue* [and] *refuse to use interpreters. . .. Communication can have negative impacts on delivery* [and the] *quality of the project."* (Interviewee 7, consultant)

The concern of clients and contractors regarding communication issues is understandable, because these categories of interviewees are at opposite ends of the construction process: one of them orders a project and the other undertakes the construction. The communication factor appears to be particularly important in this case to adequately match the needs of the client with the construction capabilities of the contractor. Consultants might be viewed as the third party and the least affected by communication issues, which is reflected in the respective response rates in Table 6.7. However, it cannot be said that communication is unimportant for consultants and their interactions with clients and contractors. This may be indicatively highlighted by the high response rates in Table 6.7.

The importance of communication risks is duly reflected in the development of the largest quantitative construct of communication in Figure 5.11. A number of specific communication-related items in the survey enabled the detailed and specific quantitative analysis of communication risks, including the finding that the communication gap between clients and contractors (Q31.8 in Appendix 4) is of the greatest importance for the communication construct (see the discussion of Figure 5.11). This is consistent with the above extracts from the interviews.

6.2.2.5 Other Risks

Other risks identified by more than 15% of all interviewees are shown in Table 6.8. The three highest-ranking risks are inadequate project management (61.54%), risk management issues (46.15%) and delays with getting approvals (46.15%) (Table 6.8). The first two risks are too general and do not provide specific insights into any risks. They are simply a general reflection of a number of issues that might be associated with project and risk management. These risks were highly ranked in terms of corresponding response rates, as many people would agree that there are general issues associated with project and risk management in the UAE. Moreover, there is no particular value in identifying these two risks because of their non-specific nature. Risk management issues in Table 6.8 is consistent with the two quantitative constructs of RM practices (Figure 5.3) and RM practice outcomes (Figure 5.1). The high frequency of identification of risk management issues in Table 6.8 is further demonstration of the importance of the previously developed quantitative constructs of RM practices (Figure 5.3) and RM practice outcomes (Figure 5.1).

The highest-ranking risk of inadequate project management is reflected in several quantitative constructs developed in Chapter 5, including project success (Figure 5.2), RM practices (Figure 5.3), internal risks (Figure 5.5), financial risks (Figure 5.6), R&T importance (Figure 5.8) and communication (Figure 5.11). The high ranking of the inadequate project management risk/node in Table 6.8 is further confirmation of the previously demonstrated importance of the quantitative constructs (Chapter 5).

The remaining third-highest-ranking risk in Table 6.8 (delays with getting approvals) is sufficiently specific to be considered an important risk in the UAE construction industry. The questionnaire instrument used for the quantitative analysis (Chapter 5) did not contain items relating to this risk. Based on the analysis of the available interview data, this risk could be a significant factor for the success of UAE projects. Therefore, it is considered worthwhile for future quantitative analysis that involves this potential risk to be conducted with the aim of confirming (or otherwise) its statistical significance in the context of the UAE construction industry.

Table 6.8: Other Risks

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Quality issues	Poor quality product	1 (50%)	3 (60%)	0	4 (30.77%)
	Client satisfaction	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Insufficient quality assurance	0	3 (60%)	1 (16.67%)	4 (30.77%)
Time delays	Time delays	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Delays with getting approvals	2 (100%)	1 (20%)	3 (50%)	6 (46.15%)
	Late supply of information	1 (50%)	1 (20%)	1 (16.67%)	3 (23.08%)
Uncategorised risks	Scope change	1 (50%)	0	4 (66.67%)	5 (38.46%)
	Legal issues	1 (50%)	2 (40%)	2 (33.33%)	5 (38.46%)
	Unable to resolve disputes	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Weather risks	0	2 (40%)	0	2 (15.38%)
	Environmental issues	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Inadequate project management	2 (100%)	5 (100%)	1 (16.67%)	8 (61.54%)
	Risk management issues	1 (50%)	4 (80%)	1 (16.67%)	6 (46.15%)
	Contractor and subcontractor risks	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Decision-making methodology	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Lack of specification and documentation	1 (50%)	1 (20%)	0	2 (15.38%)

This group of nodes includes risks (and their frequencies and category-relevant percentages of responses) that were identified as different from the previously considered constructs (Tables 6.1–6.7). For clarity and succinctness, this table only contains risks identified by more than 15% of the interviewees.

Similarly, several other risks identified in Table 6.8 exceeded the 20% identification threshold but were not directly involved or considered in the quantitative analysis (Chapter 5). These were poor-quality product (30.77%), insufficient quality assurance (30.77%), time delays (30.77%), late supply of information (23.08%), scope change (38.46%) and legal issues (38.46%). Future quantitative research should evaluate the statistical significance of these specific risks and characterise their quantitative contributions to project success and RM practice outcomes.

Contractor and subcontractor risks (30.77%), indicated in Table 6.8 as another potential risk exceeding the 20% identification threshold, was too general and non-specific to provide any useful insights into the issues dealt with by contractors and subcontractors in the UAE construction industry. Interviewees identified this risk (subsequently included in Table 6.8) because, as a result of its generality, many interviewees mentioned it in their responses. Specific risks that could be related to contractor and subcontractor risks were included in several developed quantitative constructs, such as internal risks (Figure 5.5), financial risks (Figure 5.6), R&T importance (Figure 5.8) and communication (Figure 5.11). Therefore, no further analysis of contractor and subcontractor risks can be recommended at this stage (apart from the quantitative analysis of several relevant specific risks identified in the previous paragraph).

Examples of the comments made by the interviewees in relation to the risks identified in Table 6.8 are as follows:

> *"Change in requirements . . . I link the risk management ongoing changes from the stakeholder in terms of what he needs."* (Interviewee 1, consultant)
>
> *"No risk management experience. . .. No clear and written management statements."* (Interviewee 2, contractor)
>
> *"Tight schedule . . . most of our clients unsatisfied with respect to the delivery of the project. . .. Late issue of drawings and documents."* (Interviewee 3, contractor)
>
> *"Most of work we do is on international projects, meaning that cultural and risk is a major concern for us. This includes dispute resolution groups."* (Interviewee 7, consultant)
>
> *"Training is quite important. . .. I think liability on that front is probably one of the most important risks as an engineering consultancy . . . delays in getting approval from key stakeholders."* (Interviewee 13, consultant)

Interestingly, these extracts provided a much better understanding of the specific risks meant by the interviewees in relation to the non-specific formulation of risk management issues (Table 6.8). These risks include:

- *"Contractor and subcontractor risks"* (Interviewee 3, contractor);
- *"... No clear and written management statements"* (Interviewee 2, contractor); and

- *“No risk management experience”* (Interviewees 4, contractor).

The interpretations of the above provide a number of new insights into risk management issues. Table 6.8 presents them as a useful potential construct associated with the specific risks identified above. Further, quantitative analysis and characterisation of this construct will be of interest for future research in this area.

6.2.3 Risk Management and Mitigation Strategies

Nine of the 13 interviewees suggested that risk management performance in the UAE ‘needs improvement’, ‘is challenging’ or ‘is not performing well’. This was an indication of widespread discontent regarding the current state of risk management performance in the UAE construction industry. Therefore, the interviews also focused on identifying any potential risk mitigation processes or approaches or management strategies for mitigating risks in the UAE.

The interviewees were asked to identify or comment on any such processes and strategies used in their organisation and in the wider context of the construction industry, including processes and strategies that might not currently be used, but that could be regarded as potentially useful and efficient for reducing or removing existing risks.

6.2.3.1 Current Risk Management Practices

The following interview questions asked participants about current risk management practices and strategies (Appendix 6):

- Question 6: “How do you manage risk in construction projects in the UAE?”;
- Question 7: “What processes does your organisation have for managing/mitigating risks and why?”;
- Question 8: “What decision-making and planning processes have you used to examine organisation/projects risks and why?”;
- Question 12: “Does your organisation identify economic and cultural factors as a significant influence in the UAE? If yes, please elaborate on your strategies to deal with these factors”; and
- Question 15: “What risks are typically allocated to the contractor? How are these risks offset or managed?”.

Instead of considering each question separately, the current risk management practices and strategies are identified from all of these questions and presented in the form of Table 6.9. In this way, the most important strategies are properly identified and characterised by the respective frequencies (response rates).

Table 6.9 only includes strategies that exceed the 15% response rate to ensure that any strategies identified by more than two interviewees are included in the analysis. Strategies identified by only one or two interviewees are not included because they are regarded as not sufficiently prevalent among the interviewees and the UAE construction industry. Further, some of these ‘low-frequency’ strategies are still discussed below if they are perceived by the candidate as potentially important or relevant to the discussions. This is justified because the qualitative analysis is largely based on the perceptions of the interviewees and there is no real possibility of knowing whether a strategy or practice is statistically significant within the industry or is just a result of interviewees’ other somewhat unrelated personal views.

Table 6.9: Current Risk Management Practices

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
	Use of work breakdown structures (WBS)	0	1 (20%)	2 (33.33%)	3 (23.08%)
	Quality control and assurance	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Risk management activities and training	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Risk management and mitigation	0	4 (80%)	3 (50%)	7 (53.85%)
	Monitoring and identification	1 (50%)	5 (100%)	3 (50%)	9 (69.23%)
	Risk log or register	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
Current risk management practices	Evaluation and analysis	0	4 (80%)	2 (33.33%)	6 (46.15%)
	Qualitative and quantitative analysis	2 (100%)	4 (80%)	4 (66.67%)	10 (76.92%)
	Other analysis techniques	1 (50%)	1 (20%)	3 (50%)	5 (38.46%)
	Risk response	0	2 (40%)	1 (16.67%)	3 (23.08%)
	Assign risk response owners	1 (50%)	2 (40%)	0	3 (23.08%)
	Risk planning	1 (50%)	1 (20%)	1 (16.67%)	3 (23.08%)
	Risk mitigation	0	2 (40%)	2 (33.33%)	4 (30.77%)
	None used	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Use of international standards	0	0	2 (33.33%)	2 (15.38%)

Table 6.9: Current Risk Management Practices Continued

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Current risk management practices	Engage a consultant for expert assessment and judgement	0	0	2 (33.33%)	2 (15.38%)
	Integrate risk management into program management processes	0	0	2 (33.33%)	2 (15.38%)
	Risk management as part of decision-making	1 (50%)	5 (100%)	1 (16.67%)	7 (53.85%)
	Regular communication with stakeholder	0	0	2 (33.33%)	2 (15.38%)
	Budget allowances	0	2 (40%)	0	2 (15.38%)
	Contingency funds a part of planning	0	1 (20%)	1 (16.67%)	2 (15.38%)

The group of nodes in Table 6.9 includes the current risk management practices and their frequencies and category-relevant percentages of responses identified by the interviewees. For clarity and succinctness, the table only contains risk management practices identified by more than 15% of the interviewees.

As shown, 12 strategies exceed the 20% identification rate threshold and four exceed 50%. These four strategies are risk management and mitigation, monitoring and identification, qualitative and quantitative analysis, and risk management as part of decision-making.

The interviewees' comments in relation to the most frequently identified risk management strategies were as follows:

> *"I think that the main techniques of managing risk is to operate a continuous monitoring assessment. It may be based on the risk log and its management and application. . . . The way my organisations manage that is to operate 'a top-down risk plan system'."* (Interviewee 1, consultant)
>
> *"The most commonly used tools include decision trees, planned risk responses . . . and allocating risks to 'response owners'."* (Interviewee 2, contractor)
>
> *"We produce a project risk management plan, including managing the budget . . . schedule requirements . . . risk categories . . . and risk matrix. We also manage a risk register that contains all the identified risks and their characteristics. . .. We use a risk breakdown structure (RBS) to determine risk categories."* (Interviewee 3, contractor)

> *"Good communication or good risk management plan. . .. I am a really big advocate of a risk management plan."* (Interviewee 5, contractor)

> *"I think the best way to manage construction risks is to manage design properly . . . and make sure you are designing stuff that can be actually built in that region. . .* [as well as] *risk identification* [and] *risk analysis."* (Interviewee 6, client)

> *"Once the risk has been assessed, the project team creates a risk mitigation plan to mitigate the effect of an unforeseen issue. The ways in which the specific risk is mitigated will depend on that particular risk. . .. Generally, the frameworks are avoidance* [and] *reduction risk. . .. I use contingency funds to manage unforeseen risks. . .. Regarding the strategies to deal with these factors, we transfer all risks to the contractors, because I believe they are responsible for all risks in construction projects."* (Interviewee 7, consultant)

> *"I look to examine key project areas . . . such as business policies, culture . . . resources, and tools . . . and techniques. I then use my project controls to ensure the efficient coordination and management of risks in project. . . . We also have project controls so that each area of the project is analysed to identify risks. . .. I use a daily risk management process that includes the use of clear documentation of contract procedures. . ..* [I hold] *meetings to consider key risks . . . and review action lists and responsibilities as agreed."* (Interviewee 9, contractor)

> *"We use structured processes for developing risk treatment options. This based on bow tie analysis* [and the] *evaluation of benefits and costs for the options."* (Interviewee 10, consultant)

These quotes suggest that many companies do not have a 'clear picture' of strategies and decision-making processes in relation to risk mitigation and management. It seems that many senior managers and engineers lack an understanding of risk management processes generally. This was noted in the unclear and non-specific responses of many interviewees regarding the procedures and processes for risk management and mitigation in their organisation.

In addition to this, several interviewees exposed a lack of any such procedures and processes in their organisations. As they explained:

> *"No decision-making and planning processes are used in my organisation. . .. We don't have a mitigation strategy to deal with* [economic and cultural] *factors."* (Interviewee 8, client)

> *"My organisation does not have strategies to deal with* [economic and cultural] *factors and that's a big risk."* (Interviewee 9, contractor)

This further confirms the need for rather targeted educative interventions for senior management and engineering staff in the UAE construction industry to ensure their due understanding and application of procedures and processes associated with the effective mitigation and management of a variety of existing significant risks. Some of the management and mitigation strategies and processes (Table 6.9) are reflected by the quantitative constructs of communication (Figure 5.11) and RM practice outcomes (Figure 5.1) in Chapter 5. They duly demonstrate a close relationship between those constructs to management and mitigation strategies in the construction industry. The qualitative analysis conducted in this section enabled the identification of many additional management and mitigation strategies (Table 6.9) that were not considered in the quantitative analysis or included in the survey measurement instrument (Appendix 4). Therefore, the survey instrument is extended to include the major management and mitigation strategies/processes, as well as their detailed quantitative modelling for other to do in future research.

6.2.3.2 Improvements to Risk Management Practices

Section 6.2.3 explained that there was significant and widespread discontent among participants regarding the state of risk management performance in the UAE construction industry. Not only did this justify the detailed consideration of the current risk management and mitigation processes and strategies in the industry (Section 6.2.3.1), it also suggested the need for significant improvements in such processes and strategies. Therefore, this section presents the outcomes of the qualitative analysis in terms of improvements that could be made to existing risk management and mitigation processes and strategies in the UAE construction industry. These have been mainly suggested by the interviewees involved in this study.

The interviewees identified many different approaches to improve existing risk management practices, with 22 approaches scoring above the 20% response rate threshold (Table 6.10). The improvement strategies were not considered in the quantitative analysis (Chapter 5) because they were not known at the stage of the quantitative analysis and development of the survey instrument. They became apparent only after the interviews that, according to the adopted methodology, were scheduled and conducted after the quantitative data were collected (Chapter 3). Therefore, the quantitative analysis of the improvement strategies is a matter for future research and is beyond the scope of the current study. A major achievement of this study is the qualitative identification and preliminary characterisation (via the frequency analysis of the interview data; Table 6.10) of potential strategies to improve existing risk management practices and processes in the context of the UAE.

Table 6.10: Proposed Improvements of Risk Management Practices

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Improvements of risk management process	Implement risk management process	2 (100%)	2 (40%)	3 (50%)	7 (53.85%)
	Integrate risk and project managements	0	0	3 (50%)	3 (23.08%)
	Risk response	1 (50%)	1 (20%)	0	2 (15.38%)
	Risk planning	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Risk mitigation	0	2 (40%)	2 (33.33%)	4 (30.77%)
	Risk sharing	1 (50%)	1 (20%)	1 (16.67%)	3 (23.08%)
	Qualified risk response officers	0	0	2 (33.33%)	2 (15.38%)
	Risk evaluation and analysis	2 (100%)	1 (20%)	1 (16.67%)	4 (30.77%)
	Monitoring and identification	2 (100%)	4 (80%)	3 (50%)	9 (69.23%)
Drivers for implementation of risk management processes	Senior management support	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Protection from the elements	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Use of analytical techniques	2 (100%)	2 (40%)	1 (16.67%)	5 (38.46%)
	Improve record-keeping practices	1 (50%)	1 (20%)	0	2 (15.38%)
	Regular monitoring of project and risk	0	3 (60%)	2 (33.33%)	5 (38.46%)
Experience and expertise improvements	Boosted experience & expertise	2 (100%)	4 (80%)	5 (100%)	11 (84.62%)
	Training and education	2 (100%)	4 (80%)	3 (50%)	9 (69.23%)
	Use of previous experiences	0	1 (20%)	2 (33.33%)	3 (23.08%)
Contract related improvements	Clear contractual terms & conditions	0	2 (40%)	4 (66.67%)	6 (46.15%)
	Responsibility and role allocation	0	3 (60%)	1 (16.67%)	4 (30.77%)
	Plan for controlling cost & schedule	0	4 (80%)	3 (50%)	7 (53.85%)
	Resources supply chain management	0	2 (40%)	2 (33.33%)	4 (30.77%)
	Monitoring and evaluation plans	1 (50%)	2 (40%)	2 (33.33%)	5 (38.46%)

Table 6.10: Proposed Improvements of Risk Management Practices Continued

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Contract related improvements	Ongoing review & monitoring	0	0	2 (33.33%)	2 (15.38%)
	Good forecasting of work plans	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Financial accountability and management	0	2 (40%)	2 (33.33%)	4 (30.77%)
Cultural & economic improvement strategies	Understanding of cultures & customs	1 (50%)	2 (40%)	1 (16.67%)	4 (30.77%)
	Consider religious issues & working hours	1 (50%)	2 (40%)	0	3 (23.08%)
	Multi-lingual supervisors	1 (50%)	0	1 (16.67%)	2 (15.38%)
	Team knowledge and experience	0	1 (20%)	2 (33.33%)	3 (23.08%)
	Clearly defined risk management process and plan	1 (50%)	3 (60%)	0	4 (30.77%)
	Clear roles and responsibilities	0	1 (20%)	1 (16.67%)	2 (15.38%)
Communication risk suggestions for improvement	Effective communication between all parties and workers	1 (50%)	4 (80%)	2 (33.33%)	7 (53.85%)

The group of nodes in Table 6.10 includes improvement strategies for existing risk management practices (and their frequencies and category-relevant percentages of responses) proposed by the interviewees. For clarity and succinctness, the table only contains improvement strategies proposed by more than 15% of the interviewees. The major identified strategies involve:

1. Integration of risk and project management:

   "Our companies develop risk culture and educate their workers on the importance of implementation of project risk management." (Interviewee 4, contractor)

2. Risk monitoring:

   "I think that the main ingredients, as a technique of managing the risk, is to operate a continuous monitoring assessment. . .. It may be based on the risk log and its management and application." (Interviewee 1, consultant)

3. Boosted experience and expertise of workers, engineers and managerial staff, as well as training and education:

"In our company, training is required to increase awareness of risk. . .. My company, who I work with, have more than one expert risk manager. . .. [It is important to] *learn from similar past projects."* (Interviewee 10, consultant)

"From an actual contractor point of view, I think training is a big one." (Interviewee 13, consultant)

"Project managers need expertise. . .. I think that you cannot underestimate the importance of risk management experience. . .. The project managers and key decision-makers in project must have experience in risk management." (Interviewee 3, contractor)

4. Clear contractual terms and conditions:

   "We have clear terms and conditions." (Interviewee 5, contractor; Interviewee 10, consultant)

5. Clear and efficient plan for controlling costs and schedules:

   "Organisations should develop a clear plan for schedule and cost." (Interviewee 7, consultant)

6. Improving communication between all parties to the contract and between management and workers:

   "We have good communication with client and consultant . . . because we believe that communication is number one priority for successful projects." (Interviewee 4, contractor)

6.2.3.3 Risk Allocation Practices

Table 6.11 presents the outcomes of the qualitative analysis of risk allocation practices based on the collected interview data. These allocation practices are a complex issue that some of the interviewees (particularly two consultants) could not properly respond to. One contractor indicated that, "*I found that there was a lack of risk allocation practices*" (Interviewee 5). This observation suggests that there is insufficient understanding of risk allocation practices in the UAE construction industry. As a result, risks may not be adequately allocated and managed.

Another interesting aspect that emerged from the interview data in relation to risk allocation practices was that two of the participating consultants considered fixed-price contracts that dominate the UAE construction industry. These contracts are used to transfer construction risks to contractors:

> *"My experience is that the UAE focuses primarily on fixed-price type contracts . . ..* [This] *seems to be based on the old-fashioned. . .* [In this way] *contracts can be used to 'transfer' most risks to the contractor."* (Interviewee 11, consultant)

This could be a significant cause of increased contract prices that are inflated by contractors to compensate for possible risks and contingencies during the construction process. One interviewee reported that "*pushing all risk onto the contractor generated higher prices*" (Interviewee 10, consultant).

It was indicated that the standard contractual approach in the UAE construction industry lacks proper and fair risk-sharing among parties to the contract. As explained by one interviewee:

> *"My experience is that* [such sharing] *tends to produce the best performance at the lowest cost to the principle* [client]*."* (Interviewee 11, consultant)

Table 6.11: Risk Allocation Practices

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Risk allocation practices	Shared or transferred between parties	1 (50%)	4 (80%)	4 (66.67%)	9 (69.23%)
	Allocated or transferred to contractor	1 (50%)	4 (80%)	3 (50%)	8 (61.54%)
	Allocated to the party best suited to manage the risk	1 (50%)	2 (40%)	0	3 (23.08%)
	Insurance and hedging	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Unfairness in risk allocation	0	1 (20%)	1 (16.67%)	2 (15.38%)
	Project manager responsible for risk status	1 (50%)	1 (20%)	1 (16.67%)	3 (23.08%)
	Removing fixed-price contracts to reduce costs	1 (50%)	0	1 (16.67%)	2 (15.38%)

The group of nodes in Table 6.11 includes the risk allocation practices (and their frequencies and category-relevant percentages of responses) proposed by the interviewees. For clarity and succinctness, the table only contains practices proposed by more than 15% of the interviewees.

This may suggest that risks should be shared between different parties to a construction contract rather than rigidly transferred or allocated to the contractor. Importantly, there is a consensus to this effect among the interviewees, although, as indicated above, practices on the ground do not always reflect this approach (Table 6.11). Further examples of interviewees' relevant comments in relation to risk allocation practices in the UAE construction industry are as follows:

> *"We typically only transfer risk to the contractor when this is required."* (Interviewee 2, contractor)

> *"In my experience risks can be shared. Risks are usually allocated to all the parties that are involved in project."* (Interviewee 4, contractor)

The analysis of the interview data suggests an apparent lack of evidence-based and widely adopted national strategies for risk allocation in the UAE construction industry. The standard practice of risk allocation is the indiscreet transfer of construction risks to the contractor. Moreover, there is a consensus that more flexibility is needed in risk allocation practices and that risks should be allocated to the party that is best equipped to manage them. The current widespread rigidity in risk allocation practices in the UAE construction industry can be regarded as a significant drawback in the overall risk management strategy.

6.2.3.4 Project Review and Learning Processes

The final group of nodes considered in detail in relation to mitigating strategies for risk management in the UAE construction industry is project review and learning process (Table 6.12). This group contains four issues associated with review and learning processes in relation to construction projects.

Table 6.12: Project Review and Learning Process

Construct	Nodes / sub-nodes	Client (%)	Contractor (%)	Consultant (%)	Totals (%)
Project review & learning process	Successes and failures (risks) identified during project	1 (50%)	2 (40%)	2 (33.33%)	5 (38.46%)
	Suggestions for future projects	1 (50%)	2 (40%)	2 (33.33%)	5 (38.46%)
	Financial estimates and review	0	3 (60%)	0	3 (23.08%)
	No set learning process	0	2 (40%)	2 (33.33%)	4 (30.77%)

The group of nodes in Table 6.12 includes the practices and processes associated with project review and learning from past experiences and their frequencies and category-relevant percentages of responses. For clarity and succinctness, the table only contains practices proposed by more than 15% of the interviewees.

Four out of 13 interviewees (including two contractors and two consultants) could not identify any established learning processes in their company or in the broader industry:

> *"I hate saying no, but unfortunately in my experience, there wasn't* [any learning process] *and it was something I was trying to push very hard in our company."* (Interviewee 5, contractor)
>
> "[We have] *no learning process."* (Interviewee 12, consultant)
>
> *"We don't really have learning process."* (Interviewee 9, contractor)

This can be regarded as another shortcoming in managerial approaches to risk management in UAE construction companies.

Interviewee 9 (contractor) argued that "*each project has its own risks…* [the] *risks of each project are unique,*" which justifies the absence of learning processes in the company. This opinion is not consistent with the opinions of many other interviewees and cannot justify the absence of learning processes to avoid or alleviate future risks. Moreover, as identified by the qualitative and quantitative analyses in this thesis, there is a limited number of specific risks in the UAE construction industry, and those risks are common among different projects/companies. This does not support Interviewee 9's statement. As a result, there is a significant need for well-designed targeted learning processes that focus on building effective risk management approaches based on past experiences and projects.

The two major (most prevalent) issues associated with the practices and processes of project review and learning from past experiences focus on (1) detailed analysis of successes and failures (risks) identified during the project; and (2) the development of useful and practical suggestions for future projects. These are the major goals of any learning process in relation to risk management practices in the UAE construction industry. Interviewees' relevant comments in relation to these matters were as follows:

> *"We have regular project wash-up meetings. . .. Managers and sponsors will review the major incidents and issues that occurred during the project. We will review these with the stakeholder group to agree upon what factors caused the specific issues . . .*

and on what actions can be implemented to prevent them from happening in future." (Interviewee 2, contractor)

"Yes, there is always a learning process. . .. Proper record keeping is important in construction works. . .. It helps to safeguard against mistakes that have occurred previously." (Interviewee 4, contractor)

"We strongly support the use of formal lessons learned processes as part of post-project reviews and post-investment reviews." (Interviewee 10, consultant)

"We always stress the need for projects to learn lessons throughout the project lifecycle. . .. These learnings benefit both the contractor and the principle [client]. . .. *The learning process must involve properly structured and facilitated root cause analysis and not just the listing of* [issues] *and their rectification. In my view it must cover both* [successes] *and* [failures] . . . *as providing opportunities for the contractor and the princip*le*."* (Interviewee 11, consultant)

6.3 Discussion of the Findings

This section explains the findings from the interviews and compares them with findings from the literature described in Chapter 2. The qualitative analysis has revealed a number of important risks in the UAE construction industry as well as respective strategies for effectively managing and administering these risks, including through risk allocation practices, learning and review processes and proposed improvements to existing risk management practices and processes. Most of the qualitatively identified construction risks agree with the quantitative analysis of these risks conducted in Chapter 5. The findings of the five most important risk factors, cultural diversity, economic risk, external risks, internal risks and communication risks, are in overall agreement with the findings in the literature.

Cultural diversity, external and internal risks: An organisation's vertical hierarchy (Table 6.1), trust (Table 6.1), cultural diversity (languages, customs and decision-making processes) (Table 6.2), (external cultural risks) are associated with the external risks construct (Table 6.3): cultural differences, different education, different values and work culture. Cultural external risks are among the most serious in the external risks construct. Internal risk (Table 6.6), such as site safety and poor supervision and practices. Studies in Australia (Mills, 2001), the UK (Adams, 2008), India (Dey, 2009), the US (Grace, 2010), Surabaya (Indonesia) (Chandra, 2015), Saudi Arabia (Baghdadi & Kishk, 2015), Russia (Aleshin, 2001), Spain (Cruz *et al.*, 2006), Malaysia (Hassim *et al.*, 2009), China (Ling & Li, 2012; Zou *et al*., 2007), Egypt

(Hassanein & Afify, 2007; Khodeir & Mohamed, 2015), Korea (Kim *et al*., 2015), Nigeria (Aje *et al.*, 2016), and Kuwait, Qatar and Saudi Arabia (Biygautane, 2017) have shown the existence of similar issue in those countries. While El-Sayegh (2014) found low and insignificant political, social and cultural risk in the UAE construction industry, this study and others as indicated above confirmed significant social and cultural risks, and these risks may impact the success of construction project.

Economic risks: The other major risk group concerns economic issues, as noted by Interviewee 1, a consultant, and Interviewees 3 and 4, who are contractors. They identified risks associated with several perceived constructs. For example, external risks are associated with a number of economic risks, including market demand, short-notice economic change and oil prices (Table 6.4). Financial risks (Table 6.4) include foreign exchange, inflation, budget issues, cost overrun, lack of financial resources, interest rates, increased prices of materials and rates and late payments by clients. This study's findings agree overall with those of Al Harthi (2015), Ghahramanzadeh (2013), Mott MacDonald (2002) and Ziyu *et al*. (2017) who found that the success of construction projects was influenced by market demand, inflation, interest rates, oil prices, late payments by clients and cost overrun.

In the UAE, the economic risks most important to construction projects are cash flow, lack of financial resources, inflation, price fluctuation, oil prices and late payment, all of which can be viewed as results of economic instability. (The literature review chapter provides data on the UAE economy.)

Company performance is always dependent on the economy (Flanagan & Norman, 1993; Hwang *et al*., 2017). Any company will be affected by changes in the money supply, interest rate, exchange rates, government spending, trade and oil price. The construction industry is no exception.

The primacy of the economy was first asserted by Karl Marx (1956), who referred to the economic system and the cultural system as a given society's substructure and superstructure respectively. The idea that the economy (base) determines other aspects of society such as culture, politics, and history is known as *economic determinism*.

Communication: The interviewees found poor communication between parties to be the main communication-related risk (Table 6.7). In fact, this finding had the highest identification rate amongst the interviewees. It also aligns with Al-Hajj and Sayers (2014), Biygautane (2017), Ling *et al*. (2012) and Wu *et al*. (2017), who found that poor project management skills bring about problems such as poor communication between parties. Rajkumar (2010) found that most construction projects experience a communications breakdown at some point. Project success depends significantly on the efficiency of its communication network; Interviewee 4, a contractor, considered communication the top priority for a successful project, necessary from the first day of the project to the last.

A comparison of the findings of this thesis and those described in the literature review (summarised in Table 2.5) shows that cultural diversity risk, economic risk, external risks and communication risks are not the top risks for construction projects in the countries studied in the literature. Rather, most of the critical risks for construction projects are design and technical risks; that is, internal risks. In the UAE, however, it is the economic and cultural risks that most affect construction projects, along with some internal, external and communication risks.

The interviews show that most of the critical risks are types of cultural, economic and financial risk. These risks are therefore much more significant for the contractor, who is responsible for the execution stage, than for the consultant and the client. It must be noted that some of these risks can be considered both the external and internal to the project, especially when—as is the case in the projects studied in this thesis—the client is the government. In such cases, any risk related to the client is both internal to the project, since the client is an involved party, and external, since the client is the government.

Construction risks are generally related to contractors, then to a lesser extent to clients, and then to consultants (Zou *et al.*, 2010). The ranking found in this thesis is similar but not identical. Although the contractors still have the highest risk because they are subject to construction risks, consultants are second most at risk, since they tend to face more challenges than the clients do and, in addition, are trying to make a profit from the project. Still, their tasks are much less subject to risk than those of the contractors. The clients rank last because they do not face the risks directly.

Nine of the 13 interviewees suggested that risk management performance in the UAE 'needs improvement', 'is challenging' or 'is not performing well'. This parallels the findings of Al-Hajj and Sayers (2014) and Issa (2014), who found that over one-third of UAE projects performed poorly—a level considered unacceptable. To break this down further, 34% performed poorly in terms of time, 34% in terms of budget and 32% in terms of quality (see Section 2.17 for more details about project performance). Over half of construction projects experience delays due to factors such as delay in approval of construction drawings, poor preplanning and a slow decision-making process (Faridi & El-Sayegh, 2006). The interviews also identified processes, approaches and management strategies for mitigating construction risks in the UAE.

In answering Questions 7, 11 and 12 (shown in Table 6.9), many respondents (contractors and consultants) noted strategies their companies use to manage or mitigate project risks: identification and monitoring analysis, a risk register, meetings to consider key risks, qualitative and quantitative analysis and a risk matrix. These processes help the company gather specific information about a particular project's risks so that it can plan accordingly.

The most common techniques of risk identification are checklists and brainstorming (Altoryman, 2014; Lalonde & Boiral, 2012; Zoysa & Russell, 2003). However, there is the only limited use of brainstorming analysis in the UAE construction industry. This study's results confirm those of De Oliveira *et al.* (2017) and Meng and Boyd (2017) that almost all organisations depend instead on intuition, judgment and/or experience to manage construction project risks.

To monitor risks, companies rely mainly on updating the risk register and holding regular meetings (Chapman, 2006; Lester, 2017a). Interview respondents also noted the use of a risk log (register), a document which includes all identified risks and their characteristics, such as the responsible person and the mitigation strategy. Respondents also noted that, along with regular meetings, they hold special meetings on key project risks. The risk register is developed during monitoring process and updated throughout the risk management process. Hwang *et al*. (2017) found that a risk register helps everyone involved in the project deliberately evaluate and manage the risks as part of the decision-making process. Amongst UAE construction companies, 76.9% say they use both qualitative and quantitative techniques, which is similar to Baker *et al*.'s (1999) finding of 80% in the UK.

Respondents also use the risk matrix to identify which risks are in most need of additional quantitative analysis. The effect is similar to that of using a risk ranking for the project, which makes it possible for companies to allocate risk management resources where they are most needed (Williams, 2016) and to compare projects in order to make decisions on contingency and on the project portfolio risk (Davis, 2017; Ghahramanzadeh, 2013; PMBOK, 2004).

However, any type of risk needs to be managed in order to mitigate or avoid harm and to recognise and take advantage of opportunities 'quickly'. As explained in Sections 2.5 and 2.8, the choice of procurement system and contract allocates some of that risk to other parties (Safa *et al*., 2017), generally the client or the contractor. Sometimes, a risk is more than one party can carry alone (Aje *et al.*, 2016; Davis *et al*., 2008; Hwang *et al.*, 2014; Obicci, 2017; Sastoque *et al*., 2016; Wang & Chou, 2003).

Three respondents (one contractor and two consultants) indicated in Questions 13 and 15 that risks are not allocated properly in the UAE. However, 69.23% of the respondents indicated that risks are shared or transferred and 61.54% consistently transferred or allocated risk to the contractor (Table 6.11). These two findings align with those of Bing *et al.* (2005), Osipova and Eriksson (2011) and Shen *et al.* (2006).

Osipova and Eriksson (2011) identified three bases for the allocation of construction project risk: (1) the form of a contract, (2) the arrangement of payments and (3) the management of risk in partnership projects—the principle being that risk should be assigned to whichever participant can best manage it. Bing *et al*. (2005), analysing risk allocation in PPPs in the UK, find that contractors charge more when more risk is assigned to the private sector than they do when more risk is assigned to the public sector. They identify four approaches to risk allocation: (1) risk should be handled to the private sector (i.e., the contractors); (2) risk should be handled to the public sector (i.e., the clients); (3) risk should be shared between private and public sectors; and (4) risk allocation may dependent on a particular project. Shen *et al*.'s (2006) study of typical PPP contracts in Hong Kong also revealed the principle of allocating risk to the party that could handle it best. Bing *et al*.'s (2005), Osipova and Eriksson's (2011) and Shen *et al*.'s (2006) findings are all generally consistent with those of this study: sharing or transferring construction risks amongst contractors and allocates risk to the party best able to manage it (Table 6.11).

Although some of the observed allocations do not appear to be rational, most do. Given a risk of the client's delayed payment to contractors (Table 6.4), some contracts allocated the risk to the client, some to the contractor and some to both. The best choice is an allocation to the client, as found in studies in the US (Kangari, 1995), Kuwait (Kartam & Kartam, 2001), Taiwan (Wang & Chou, 2003) and Colombia (Sastoque *et al*., 2016). The interviews revealed that international and local respondents varied significantly in their allocation of risk due to differences in culture, decision-making processes, education, values and work culture.

Risk management consists of identifying and evaluating risks to implement risk responses aligned with a project's objectives (Wibowo & Taufik, 2017). Flanagan and Norman (1993, p. 31) define decision-making as *"a game of imperfect information involving the future, change,* *and human action and reaction."* Such a process will not result in absolutely right (or absolutely wrong) decisions, but helps a company make better rather than worse decisions. However, this study found that, thanks largely to cultural gaps, there is a significant lack of risk management knowledge in the UAE, as seen in Questions 6, 7, 8, 11, 12 and 15 and in the results of RM Practices (Model 1) in Section 5.3.1.1. This lack seriously undermines UAE construction companies' risk management strategies and the decisions based on them.

Since risk involves the future, the laws of probability, which can be used for prediction, are central to risk management. As Bernstein (1996) asserts, the laws of probability are the most powerful risk management tools available. Two approaches to using these tools can be identified: (1) objective probabilities, based on repeated observations of given events, and (2) subjective probabilities, based on the degree to which a given decision-maker believes (based on available data) that given events are likely to happen. Because construction projects tend to be unique, subjective probabilities are likely to be the strongest and most commonly used approach to risk decision-making. For that reason, this study recommends a process by which project managers learn to make the best use of their past experience.

Responses to Question 18 indicate that such a learning process may not be carried out efficiently due to an unsupportive culture and to a lack of risk management expertise. Some companies lacked a well-organised experience was also considered of limited value process for evaluating the strengths and weaknesses of their projects for lessons applicable to future projects, due to a belief that managers could gain applicable experience simply by carrying out their projects. Past experience was also considered to be of limited value because one project tends to be so unlike another. As quoted earlier, "Each project," said Interviewee 9, *"has its own risks. . ..* [The] *risks of each project are unique."*

Other interviewees, however (Interviewees 2 and 4, contractors, and 10 and 11, consultants) replied that the two most prevalent issues in learning from past experiences focus on detailed analysis of successes and failures (risks) identified during the project and the development of practical suggestions for future projects (Table 6.12). According to those interviewees, these are the top goals of any learning process for risk management practices in the UAE construction industry.

Still, decisions on how to manage an uncertain future cannot be founded solely on past experience. Each new project also requires risk identification and management based on its specific characteristics. By employing the laws of probability, risk management allows for proactive decision-making, typically based on contingency plans designed to support the base plan, which is a proactive strategy. Since managers can never predict all the possible outcomes, reactive planning is also necessary when the proactive plan results in a risk crisis. However, appropriate risk management significantly reduces the occasions requiring crisis management (Chapman & Ward, 2004; Ghahramanzadeh, 2013; Lester, 2017a). In turn, one element of the risk management process is to estimate the contingency costs for such crisis management as may be needed.

Risk vulnerability due to lack of risk management expertise is certainly not unique to the UAE. Aje *et al.* (2016), Cruz *et al*. (2006), Kim *et al*. (2015) and Liu *et al*. (2007) find similar vulnerabilities in Nigeria, Spain, Korea and China respectively. There is much to be gained all over the world from better learning processes focussed on the risk management process.

6.4 Conclusion

This chapter discussed the major outcomes of coding and qualitative analysis of the 13 semi-structured interviews undertaken in this study. The qualitative analysis has revealed a number of important risks in the UAE construction industry as well as respective strategies for effectively managing and administering these risks, including through risk allocation practices, learning and review processes and proposed improvements to existing risk management practices and processes. Most of the qualitatively identified construction risks agree with the quantitative analysis of these risks conducted in Chapter 5 (e.g., cultural diversity, economic risk, external risks, internal risks and communication risks). Further, interviewees identified several additional risks by participating in the qualitative analysis, including:

- The cultural need for personal trust during business operations, which could be a hindrance for foreign companies or foreign workers (Table 6.1);
- The presence of a large number of expatriate workers (whether as a positive or negative factor, further research is needed) (Table 6.2);
- Government financing of most construction projects, including potential risks associated with the dominance of financial sources for construction (further research is needed) (Section 6.2.2.2);
- Inadequate quality control in relation to workers' performance (Table 6.6);
- Poor communication between parties (Table 6.7);
- Legal issues and inability to resolve disputes (identified by around 40% of the

interviewees) (Table 6.8);

- Delays with getting approvals (Table 6.8);
- Poor-quality product (Table 6.8);
- Insufficient quality assurance (Table 6.8);
- Time delays (Table 6.8);
- Late supply of information (Table 6.8);
- Scope change (Table 6.8); and
- Risk management performance in the UAE ‘needs improvement’, ‘is challenging’ or ‘is not performing well’ (Section 6.2.3).

The qualitative analysis also identified several additional potential constructs, including:

- Poor supervision of risk management, poor risk management analysis and planning within the company (Table 6.6);
- Risk management issues (Table 6.8);
- Inadequate risk management experience (Table 6.8);
- Contractor and subcontractor risks (Table 6.8);
- Several constructs for proposed improvements to risk management practices, including (Table 6.10):
  - Improvements to risk management process;
  - Drivers for the implementation of risk management processes;
  - Experience and expertise improvements;
  - Contract-related improvements; and
  - Cultural and economic improvements.
- The standard practice of risk allocation in the UAE construction industry was via an indiscreet transfer of construction risks to contractors. There was a consensus that more flexibility is needed in risk allocation practices and risks should be allocated to the party that is best equipped to manage them (Table 6.11); and
- The two major (most prevalent) issues associated with the practices and processes of

project review and lessons learnt were (Table 6.12):

a) Detailed analysis of successes and failures (risks) identified during the project; and

b) Development of useful and practical suggestions for future projects.

The detailed quantitative analysis of these constructs, including the validation and evaluation of their effects on project success in the UAE construction industry, is beyond the scope of this thesis, but will constitute important topics for future research.

In general, and as expected, the qualitative outcomes have further corroborated and thus triangulated the quantitative findings presented in Chapter 5 and they have identified several additional risks and mitigating strategies. Both the quantitative and qualitative outcomes of this thesis will be important for further development and modernisation of the UAE construction industry in terms of boosting its productivity and effectively managing any emerging risks and contingencies.

Chapter 7 provides an overall summary of the study and the conclusions based on the results and findings of the data analysis. It then summarises the major quantitative and qualitative findings, posed some recommendations and explains future research directions and identifies the limitations of this thesis.

Chapter 7: Conclusion

7.1 General Conclusion

This chapter summarises the major quantitative and qualitative findings of this thesis. It also provides recommendations for the construction industry, outlines future directions for research and discusses the limitations of this study.

The outcomes and findings of this thesis make a contribution to the current general and practical knowledge in risk management research in the construction industry in the UAE. The analyses and modelling demonstrated the consistent use of modern statistical and other analytical methodologies for the reliable identification and detailed characterisation of risks in construction, including major economic and cultural risks and risk factors in the UAE. Risk management practices and their improvement strategies were also considered and analysed in detail using quantitative and qualitative analytical approaches.

The reliability of the outcomes was corroborated by the consistent nature of the modelling based on GSEM and exploratory and confirmatory factor analyses, albeit within the limitations and applicability conditions of the methods and methodological approaches (see Section 7.5 for a more detailed discussion of the study's limitations). The implemented factor analyses enabled the construction of new latent variables (factors or constructs) describing themes or groups of specific risks measured by the survey instrument (e.g., the factor of cultural diversity, UAE culture and communication).

Each risk factor was associated with a group of questionnaire items (specific risks) that described their common aspect (e.g., associated with the notion of cultural diversity or communication issues). This was an important step in establishing commonality and enabling the generalisation of numerous specific risks that could be defined and formulated differently for various business environments and countries and that might be prone to misinterpretations and identification errors into statistical constructs that are much less susceptible to questionnaire formulations and that represent the general risk factors or themes. There is a lack of such in-depth and rigorous analysis in general in the existing literature for the UAE construction industry. Apart from those major research literature gaps, as identified in the questions posed in this thesis, another important and major knowledge gap is regarding the nature of the methods used in risk management research, which this thesis addresses.

This thesis develops risk factors (constructs) in the UAE context and uses them to develop quantitative relationships. The relations found between these the constructs and survey items (associated with the constructs) will help to efficiently identify priority areas that should be targeted to develop the most efficient risk management strategies in the construction industry. Moreover, as discussed in Chapter 2, the disciplinary significance of the findings of this research is contextual, descriptive and explanatory. Accordingly, this study is not contributing to a general or decontextualised theory of the relationship between project management, risk, risk management, culture, economic and project success, but a contextual contribution to the current general knowledge of risk management research in the construction industry in the UAE.

The findings of this study, including the development of the risk factors representing the common characteristics of various similar risks, will also contribute to reducing the diverse construction risks identified by other researchers and research groups (Khodeir & Mohamed 2015; Musa *et al*., 2015). The diversity of previous research findings is a contribution complication for the practical application of any outcomes and the development of reasonable recommendations to governments and construction managers. It originates from a lack of consensus among research groups in defining and identifying construction risks (Motaleb & Kishk 2015; Renuka *et al*., 2014) and from the absence of a systemic analytical approach to identifying and characterising common aspects of similar risks and their association with overarching risk constructs (Bollen, 1987; DiStefano *et al*., 2009; Yong & Pearce, 2013).

The current study has contributed to resolving the problem mentioned above by systematically constructing risk constructs/factors in the UAE construction industry. There are significantly fewer risk factors compared with the risks specifically identified by the survey instrument, and they are expected to be widely applicable and comparable under different conditions in a variety of construction industries.

The lower number of risk factors compared to the individual risks given by the survey items enabled a more efficient quantitative evaluation of mutual relationships between the developed risk factors (risk themes) and their effect on project success and risk management practice outcomes. The adopted GSEM analytical methodology allowed for the simultaneous consideration of numerous variables measured by the survey instrument and the constructs (risk factors), some of which had significant correlations with each other. As a result, detailed networks of direct and indirect effects of the risk factors and variables on project success and risk management practice outcomes (networks of effect paths) were developed to characterise, for the first time, risk factors and risk management practices in the UAE construction industry. Special attention was paid to analysing the effects of economic and cultural risk factors on project success. Two significantly separate networks of effect paths were developed for the economic and cultural risk factors, thereby demonstrating their importance for project success and overall risk management practices in the UAE construction industry.

Several research groups have previously attempted to use GSEM to identify risks in construction industries and characterise their direct and indirect effects on project outcomes and project-related performance (Chandra, 2015; Doloi *et al*., 2012; Eybpoosh *et al*., 2011; Kim *et al*., 2009; Liu *et al*., 2016; Low *et al*., 2015; Sambasivan *et al*., 2017; Wang *et al*., 2016). However, none of the studies have identified and/or evaluated risks in the UAE construction industry. As a result, previous efforts in this area cannot be regarded as reliable or conclusive (Al Ariss & Guo, 2016; Al Mousli & El-Sayegh, 2016; Al-Sabah *et al*., 2014; El-Sayegh, 2008, 2014; El-Sayegh & Mansour, 2015; Faridi & El-Sayegh, 2006; Juaidi *et al*., 2016; Ling *et al*., 2012; Motaleb & Kishk, 2010, 2013, 2015). This highlights the importance and significance of the achievements and findings of the current study in bridging the knowledge gap in risk management research in the UAE construction industry.

The significance of the methodological advancement achieved by this thesis largely based on the consistent use of the GSEM analysis is not limited to the context of the UAE construction industry. The methodological approaches can be used to enhance knowledge in risk management research and improve management strategies in a variety of countries and industries. As noted earlier, this is another major contribution of this thesis to the general and practical knowledge in risk management research. The nature of the findings developed from the method will assist with the development of useful recommendations and useful best practice guidelines for governments and construction managers in the UAE and around the world.

The existing literature has mostly been concerned with identifying construction risks and possible strategies for managing such risks; however, few studies have established the effectiveness of such strategies (Kutsch & Hall, 2010). This appears to be a general problem and is not limited to the UAE context. This study has attempted to bridge this gap by undertaking a detailed qualitative analysis of perceived improvements in strategies to mitigate construction risks and risk factors.

A combination of these findings and future quantitative analysis of such strategies and their possible improvements will close this knowledge gap and enable the optimisation of existing and future risk mitigation strategies in the construction industry. The findings of this study are reported in the following section and the significance in relation to the research questions will be established.

7.2 Major Study Findings

7.2.1 Major Quantitative Findings

The major quantitative findings of this study are outlined below.

1. Perceptions of risk management failures and difficulties were found to be significantly more prominent for construction employees with little work experience in their current role (less than or equal to five years) and with greater work experience (more than 15 years). In contrast, employees with six to 15 years' experience in the job tended to evaluate the success of construction projects more positively than employees with less or more work experience. This outcome was consistent in all five models developed in this study and was therefore conclusive.

2. Formal implementation of risk assessments had a strong positive effect on the improvement of risk management practice outcomes (Figures 5.12 and 5.14). Therefore, formal risk assessment and management in construction projects was important for construction companies that intend to reduce their risks.

3. Unexpectedly, risk-averse companies were strongly and positively associated with perceived difficulties in the identification, assessment and management of risks in the UAE construction industry (Figures 5.12 and 5.14). Thus, risk-averse construction companies were, on average, overcautious in their attempts to avoid risks and they did not have realistic and effective strategies for risk mitigation. This was detrimental for their business and overall risk management. A better approach may be to identify, assess and manage risks in a calculated way.

4. Construction companies with key activities in the industrial sector managed risks significantly better (with the probability of an 'excellent' risk management rating up to approximately1.5 times greater; Figure 5.16b) than those with key activities in sectors other than the industrial sector (e.g., housing).

5. None of the cultural risk factors (UAE culture or cultural diversity) had a significant direct effect on project success in the UAE construction industry. However, both constructs had strong indirect effects on project success through the mediation of

external risks, internal risks and communication (Figure 5.17).

6. UAE cultural features and cultural diversity were mostly detrimental for project success in the construction industry (as illustrated by the negative signs of the indirect effects of the cultural factors in Figure 5.17 and Equations 5.20a and 5.20b). There were only two exceptions to this general finding:
    - Compared with many Western countries, the more stringent attitude towards time in the UAE culture (Figure 5.9) was significantly positive for the success of construction projects (Figure 5.17); and
    - Various education backgrounds within the workforce had a positive (albeit not as strong and not as significant) positive effect on the success of construction projects (see Figures 5.10 and 5.17).
7. All other cultural risks and cultural diversity risks (Figures 5.9 and 5.10), including preferences to conduct business face to face and have personal knowledge of a business partner as well as the strong vertical hierarchy of most Emirate companies appeared to be significantly detrimental to project success and in the risk management involved in the UAE construction industry sector.
8. The negative effect of cultural diversity was more than two times stronger on project success than UAE culture (Figure 5.17 and Equations 5.20a and 5.20b), thereby demonstrating the importance of risks associated with cultural diversity (Figure 5.10).
9. Of the eight risk constructs: financial risks, contract importance, R&T importance, communication, internal risks, external risks, UAE culture and cultural diversity but the most important ones were external risks, communication, cultural diversity and R&T importance.
10. Increasing communication efficiency resulted in decreasing the perceived importance of contractual and R&T matters for project success (see the respective negative effect signs of the communication construct in Figure 5.20). That is, better communication tended to reduce (compensate for) the perceived need to develop a clear and efficient contract and to have efficient R&T delivery and planning.
11. Deficiencies and shortcomings in communication (including those caused by cultural issues and external risks) could be at least partly counteracted by developing clear contracts duly considering and addressing financial liabilities, budget allocations and

bills of quantities, accounting standards and terms and conditions, and project planning and duration, and by involving reputable market consultants (Figures 5.7 and 5.8).

12. The CFA and GSEM modelling identified the 9 most critical individual risks for the success of UAE construction projects as
    - Inadequate forecast about market demand;
    - Lack of adequate financial accountability and management;
    - Language diversity;
    - Diversity of decision-making processes;
    - Lack of effective dispute-resolution procedures;
    - Large communication gap between contractors and clients;
    - Lack of an effective system to communicate risks;
    - Lack of an effective system to communicate risk mitigation strategies; and
    - Large communication gap between contractors and employees.

Adequate management of these risks is likely to provide the largest and quickest benefits for construction companies in terms of effective risk management.

13. On-schedule delivery of a construction project was not considered essential (or significant) for overall project success. In contrast, on-budget delivery was highly significant and important for project success (Figure 5.23).

7.2.2 Major Qualitative Findings

The major qualitative findings of this study are outlined below.

1. As a result of the qualitative analysis (Chapter 6), the following issues were also identified as potential risks in the UAE construction industry:
    - The cultural need for personal trust during business operations, which could be a hindrance for foreign companies and foreign workers (Table 6.1);
    - The large number of expatriate workers (as a positive or negative factor, further research is needed) (Table 6.2);
    - Government financing of most construction projects, including potential risks associated with the dominance of financial sources for construction (further

research is needed) (Section 6.2.2.2);

- Inadequate quality control in relation to employees' performance (Table 6.6);
- Poor communication between parties (Table 6.7);
- Legal issues and inability to resolve disputes (identified by around 40% of the interviewees) (Table 6.8);
- Delays with getting approvals (Table 6.8);
- Poor-quality product (Table 6.8);
- Insufficient quality assurance (Table 6.8);
- Time delays (Table 6.8);
- Late supply of information (Table 6.8);
- Scope change (Table 6.8); and
- Risk management performance in the UAE 'needs improvement', 'is challenging' or 'is not performing well' (Section 6.2.3).

2. The standard practice of risk allocation in the UAE construction industry was via an indiscreet transfer of construction risks to contractors. There was a consensus that more flexibility is needed in risk allocation practices and risks should be allocated to the party that is best equipped to manage them. Current widespread rigidity in risk allocation practices was a significant drawback in the overall strategy of risk management in the UAE construction industry.
3. The two major (most prevalent) issues associated with the practices and processes of project review and lessons learnt were:

   a) Detailed analysis of successes and failures (risks) identified during the project; and

   b) Development of useful and practical suggestions for future projects.

These are the major goals of the learning process and findings related to risk management practices in the UAE construction industry.

4. Several other potential constructs were found for further research as a result of the qualitative analysis (Chapter 6):

a) Poor supervision of risk management, poor risk management analysis and planning within the company (Table 6.6);

b) Risk management issues (Table 6.8);

c) Inadequate risk management experience (Table 6.8);

d) Contractor and subcontractor risks (Table 6.8);

e) Several constructs related to the proposed improvements of risk management practices (Table 6.10):

   - Improvements to risk management processes;
   - Drivers for implementation of risk management processes;
   - Experience and expertise improvements;
   - Contract-related improvements; and
   - Cultural and economic improvements.

f) Risk allocation practices (Table 6.11); and

g) Project review and learning process (Table 6.12).

More specifically, based on the research findings listed in Section 7.2.1 and 7.2.2, the answers for the following research questions as posed in this study in order to achieve the major aims and objectives of this thesis are answered below.

Research Question 1: What are the major risks and risk factors (including any cultural and economic risks) and what are their effects on UAE construction projects?

In paragraph eight in Section 7.2.1, the major (most important) risk factors identified in this study were external risks, communication, cultural diversity and R&T importance. These factors had the largest total effects on project success (see Equations 5.20a–b, 5.24a–b and 5.33a–d) and must be regarded as the dominant factors when considering any strategies for risk mitigation and/or improvements to risk management in the UAE construction industry.

The 9 most critical individual risks are listed in Section 7.2.1 This identification was based on the determination of the most important individual risks (i.e., those with the largest magnitudes of factor loadings) associated with the four most important factors identified in the previous paragraph.

Thus, this study answered Research Question 1 but did not attempt to analyse the additional risk constructs and individual risks identified by the qualitative analysis (see Chapter 6 and Section 7.2.2). This was beyond the scope of the current study and will constitute a topic for future research (see Section 7.4).

Research Question 2: What are the major risk management practices in the UAE construction industry and what are their effects on project success and management?

This research question was answered by developing two GSEM models: Model 1 and Model 2 (Figures 5.12 and 5.14) as well as the constructs of research management practices and research management practices outcomes (Figures 5.3 and 5.1). Both models established significant direct relationships between successful risk management outcomes and the presence of risk management strategies and effective interactions between the risk management team and companies' employees.

In addition to this, the presence of expert risk managers and the implementation of formal risk assessments within construction companies provided major positive benefits for current risk management practices. Importantly, risk-averse companies were perceived as those that were unable to manage construction risks successfully. This was reflected in the list of major quantitative findings outlined in Section 7.2.1.

Research Question 3: What are the effects of demographic and company variables on project success in the UAE construction industry?

The effects of demographic and company variables were considered and characterised in all five GSEM models developed in this thesis. Several variables had significant direct and indirect effects on the success of risk management outcomes and current risk management procedures and strategies (Models 1 and 2 in Figures 5.12 and 5.14). The related findings associated with these variables are listed in Section 7.2.1.

In addition to this, several demographic and company variables had significant direct effects on the constructs of external risks, internal risks, communication, project success and contract importance (Figures 5.17 and 5.20 and Tables 5.11 and 5.12). The variables that had significant effects in Models 3 and 4 were company type, key company activities, job title, years in the role, gender and education.

The significant direct effects of the above variables on any constructs apart from project success also caused significant indirect effects on project success (Figures 5.17 and 5.20). The effects of these demographic variables reflected the differences in the perceptions of construction risks and risk management outcomes by different groups (categories) of study participants. That is, the models were appropriately adjusted for the demographic and company variables. This resulted in more reliable outcomes and findings as well as a significantly lower probability that the findings would be affected by unknown confounders.

Research Question 4: How can risk management practices in UAE construction projects be improved?

This research question was addressed in the qualitative analysis (Chapter 6), which was chosen for the evaluation because there was little information in the current literature regarding possible and/or perceived improvements to risk management practices in the UAE construction industry. This lack of reasonable information did not allow for the development of a structured survey instrument to quantitatively evaluate improvements to risk management practices. Therefore, the fourth research question was answered using semi-structured interviews, which enabled the capture and identification of any perceived risk management improvements (see Section 6.2.3.2 and 7.2.2).

7.3 Recommendations

The findings derived and explained in this thesis have enabled the development and formulation of the following practical recommendations to the government and industrial organisations, aimed at improvement of risk management in the UAE construction industry.

7.3.1 Recommendations for Government and Economic Organisations

1. Improve and expand the diversification of financial sources for the construction industry to reduce risks and shortcomings associated with dominant government financing.
2. Avoid delays with, simplify and improve government approval processes for construction projects, particularly those that are financed by the government.
3. Consider the development and promotion of more flexible government contracts with contractors and consultants based on the flexible allocation of risks instead of fixed-cost contracts that allocate all risks to contractors. This is an important and useful approach that has been widely recognised in developed countries and has been proven to significantly reduce contract costs and improve flexibility and efficiency of risk allocation practices.

7.3.2 Recommendations for Private Construction Companies

1. Formal implementation of risk assessment and management strategies may be a priority for construction companies that intend to reduce their risks.
2. Employing one or more expert risk managers in a company significantly alleviates difficulties with risk management.
3. Identify, assess and reasonably manage any emerging risks (rather than simply trying to avoid them) for the benefit of the company and its projects. Taking calculated and managed risks may be good for business and project success.
4. When managing and reducing internal risks, focus on site safety, design changes and errors, and retaining a qualified workforce. Issues associated with inadequate project planning, organisational structure and project teams were internal risks of lesser importance.
5. Concentrate on all financial risks that are within a company's control, including cash flow management, better communication and agreement with clients to ensure their payments are on schedule, better financial operations and management (reducing cost overruns) and more reliable internal forecasting of and planning for inflation and exchange rates.
6. To manage and mitigate contractual risks, priority should be given to evaluating contractors' financial viability and liabilities and conducting better work planning and estimations of project duration. The allocation of extra funds for the bidding stage and employing consultants to forecast market demand were less important in terms of effective reduction of contractual risks.
7. To manage and mitigate R&T risks, priority should be given to management and financial accountability relating to the efficient supply of the required materials and equipment. Although also statistically significant, the use of efficient project-related technologies was not perceived as a priority for R&T risks.
8. To manage and mitigate the risks associated with cultural diversity, priority should be given to managing and overcoming language barriers, ensuring a diversity of decision-making cultures and developing efficient dispute-resolution procedures and practices. Proper management of the existing cultural diversity of the workforce and workplace cultures (including through effective dispute-resolution procedures and managing

language diversity) might have contribution benefits and could convert cultural diversity into a positive factor for risk management and project success in the UAE construction industry.

9. To manage and mitigate the risks associated with communication, priority should be given to managing and reducing communication gaps between contractors and clients, and between contractors and employees, as well as developing effective systems of communication regarding risks and their mitigation strategies. Reporting procedures between staff and top management and the communication gap between contractors and consultants were less important.
10. One way to counteract deficiencies in communication (including those caused by cultural issues and external risks) is to develop clear and efficient contracts with the involvement of reputable market consultants and duly considering and addressing financial liabilities, budget allocations and bills of quantities, accounting standards and terms and conditions, and project planning and duration.
11. To obtain the fastest benefits from risk management, priority should be given to the 9 most critical risks identified in Section 7.2.1.
12. Establish and apply practices and processes of project review and learning from past experiences by:
    a. Conducting a detailed analysis of successes and failures (risks) in past projects; and
    b. Development of useful and practical suggestions for future projects.

7.4 Future Research

Several areas or directions for future research were identified during the analysis and modelling processes. They are mostly relevant to issues that are beyond the scope of this study. Directions for future research include the following:

1. Quantitative analysis of the findings obtained using the qualitative methods is important to confirm and characterise the findings in a rigorous statistical way (including any related levels of statistical significance and confidence intervals). This includes the following future research directions:

a. There should be some targeted research into potential risks associated with the domination of government financing of the UAE construction industry;

b. There should be more detailed quantitative analysis and confirmation of other potential risks identified in the qualitative analysis;

c. There should be a focus on potential new risk constructs identified in the qualitative analysis (see Section 7.2.2); and

d. The research in future may pay attention to specific risk mitigation strategies and concentrate on their potential improvements.

2. There is a need to study the effects of gender on the perception of RM practices and their outcomes. This is required because the sample of participants available for the current study did not allow the reliable determination of potential differences between the views and perceptions of the different genders, although some indications of such differences were obtained (e.g., Figures 5.12 and 5.20).

3. There is a need for further work is to understand the concept of reverse confounding, such as its effect of project success (which was used in this study as a dependent construct) on contract importance and R&T importance (see the discussion of Figure 5.20). It was not possible to focus on this in the current study because of the specific design of the survey instrument and limitations of the sample size.

4. The potential bias of the participants relating to the fact that they were all employees of or otherwise associated with construction companies should be considered in future research. As indicated above, this might be particularly important for the evaluation of external and contractual risks, including any perceived recommendations to the government and regulating authorities.

7.5 Limitations of this Research

As explained in Section 7.1, the outcomes and findings of this study represent a contributing step forward in the domain of risk management research in the UAE construction industry as well as in the broader context of other countries and regions. The research undertaken, results and findings reported in this thesis was naturally associated with several designs and methodological limitations that may include the following:

1. The study was based on a sample of cross-sectional data suitable for the analysis of patterns of trends associated with risk management in the UAE construction industry at the time of the data collection. The collected data did not consider the evolution of existing risks in time, and it was limited to the UAE context.

2. The study used survey data based on the opinions of employees of construction companies. The participants may have been biased because of their association with or employment by construction companies, which may have resulted in biased perceptions and risk evaluations. This might be particularly relevant for the evaluation of external and contractual risks. For example, the discussed bias could be, at least partly, a reason for the finding that the best way to tackle the risks associated with variability of market demand is through external bodies (see the discussion of Figure 5.4), whereas efforts of individual companies might still be required.
3. The study was based on the voluntary self-selection approach in which the participants expressed their willingness to participate in the survey and/or subsequent interviews. Self-selection is associated with a possibility of bias related to the non-probabilistic selection of the sample of participants as is the case with most qualitative studies. The potential bias associated with self-selection is a limitation.
4. The sample size was based on 237 observations (participants) did not allow the consideration of all developed constructs in one GSEM model. Therefore, two separate models were used (Models 3 and 4), focusing on different sets of independent constructs. As a result, constructs from different sets may have additional direct and indirect effects on each other and may change some of the models' parameters. Any such changes would not lead to significant alterations of the outcomes and recommendations because both models agreed with each other.
5. The outcomes (particularly the negative relationships between contract importance and project success and between R&T importance and project success in Model 4) indicated a possible confounding effect of project success on contract importance and R&T importance (see the discussion of Figure 5.20 and Equations 5.33b and 5.33d). Detailed analysis of this confounding effect was impeded in this study by the structure of the survey instrument (which was not designed to capture this effect) and the relatively limited sample of 237 participants. Therefore, this issue requires further work.
6. The distributions of the survey item responses were typically non-normal. It was suggested that typical non-normal distributions of survey responses do not result in major errors in outcomes (Xiong *et al.*, 2015). However, the applicability condition for the standard GSEM and CFA analyses was the required normality of distribution of the variables (StataCorp, 2015). Therefore, the analysis in this thesis was conducted using

the asymptotic distribution-free approach in GSEM and CFA, which further reduced the errors associated with non-normal variable distributions (StataCorp, 2015). However, this should still be regarded as a limitation because the asymptotic distribution free approach is not available in GSEM, and the strict approach would have been the generalised response factor model with ordered probit (Greenacre, 2006; StataCorp, 2015). This model would have introduced a new complexity dimension into the analysis, which was regarded as unreasonable for the study.

7. The qualitative analysis was conducted based on interview data collected from 13 participants to further corroborate the quantitative findings and identify any additional potential risks and risk management approaches that were not covered by the survey instrument. However, the qualitative analysis and its findings were exploratory in nature. Therefore, the findings were limited to reasonable indications that must be further confirmed and quantitatively characterised using statistical methods (including levels of significance, model fit and prediction intervals). Therefore, qualitative findings (Chapter 6) that are in addition to the quantitative findings (Chapter 5) should be treated as indications of additional potential risks, risk management approaches and/or their potential improvements.

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Appendix 1: Ethics Approval

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

HUMAN RESEARCH ETHICS COMMITTEE
Bond University
Gold Coast, Queensland 4229
Australia
Ph: +61 7 5595 4194
Fax: +61 7 5595 1528
(from overseas)
Email: ethics@bond.edu.au
ABN 88 010 694 121
CRICOS CODE 00017B

19 December 2016

Michael Regan
Faculty of Society and Design
Bond University

Dear Michael

Application ID: **15806**
Project Title: **An Investigation into Risk Management in Construction Projects within the United Arab Emirates**
Researchers: **Michael Regan, Mundhir Mahmood Abdullah Al Hasani**

I am pleased to confirm that your project was reviewed by Bond University Human Research Ethics Committee and you have been granted approval to proceed.

The Committee requires, as a condition of approval, that all investigations be carried out in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research* (2007). Approval is subject to conduct of the research in accordance with the requirements set out in the National Statement.

Approval is given subject to the protocol of the study being undertaken as described in your application, and approved amendments. As you may be aware the Ethics Committee is required to annually report on the progress of research it has approved. We would greatly appreciate if you could respond promptly and fully to the request for information on this project which will be distributed in March/April each year.

Under the terms of the National statement BUHREC has a role to monitor approved research projects and if necessary may withdraw approval. Conduct of unapproved research or deviation from the approved protocol may constitute academic misconduct and will be investigated in accordance with Section B of the *Australian Code for the Responsible Conduct of Research* (2007). Please refer to the Research Ethics website for more detail on Research Integrity and Bond University processes for dealing with instances of research misconduct.

You are reminded that the Principal Investigator must immediately report anything that might warrant review of ethical approval of the project. Should you have any queries or experience any problems, please contact us promptly.

We wish you well with your research project.

Yours sincerely

Dr Mark Bahr
Chair Bond University Human Research Ethics Committee

www.bond.edu.au

Appendix 2: Invitation to Participate in a Research Project

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

FACULTY OF SOCIETY & DESIGN
Bond University
Gold Coast, Queensland 4229
Australia

Toll free 1800 650 121
(within Australia)

Ph: +61 7 5595 2522
Fax: +61 7 5595 1474
(from overseas)

Email: fsd@bond.edu.au

ABN 88 010 694 121
CRICOS CODE 00017G

Invitation to participate in a research project

"Date"

Dear "Name",

The purpose of this letter is to invite you to participate in a postgraduate research study. The participant information sheet enclosed provides details of the purpose of the study, which you need to consider before deciding whether you would be willing to take part.

You are Not obliged to take part in this study. If you do agree to participate, you remain free to withdraw from the study at any time and may do so without any disadvantage to yourself and without any obligation to give a reason.

If you decide that you would like to participate in the study once you have considered the information provided, please complete and return the enclosed consent form and the questionnaire provided.

Participants will be provided with summary of the results on request. Please do not hesitate to contact me if you would like to discuss the information provided or ask any questions before agreeing to part in the study.

Many thanks for taking the time to read this information.

Yours sincerely,

Mundhir AL hasani
PhD Candidate, Bond University
M.alhasani@student.bond.edu.au

Appendix 3: Participant Consent Form

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

FACULTY OF SOCIETY & DESIGN
Bond University
Gold Coast, Queensland 4229
Australia
Toll free 1800 650 121
(within Australia)
Ph: +61 7 5595 2522
Fax: +61 7 5595 1474
(from overseas)
Email: fsd@bond.edu.au
ABN 88 010 694 121
CRICOS CODE 00017B

PARTICIPANT CONSENT FORM

STUDY TITLE	**An Investigation into Risk Management in Construction Projects within the United Arab Emirates**
BOND UNIVERSITY ETHICS No.	**0000015806**

The study has been explained to me in a language that I understand. I have read the information letter relating to the above programme of research in which I have been asked to participate and have been given a copy to keep. The nature and purpose of the research have been explained to me, and I have had the opportunity to discuss the details and ask questions about this information. I understand what is being proposed and the procedures in which I will be involved have been explained to me.

I understand that my involvement in this study, and the particular data from this research, will remain strictly confidential. Only the researchers involved in the study will have access to the data. It has been explained to me what will happen to the data once the research programme has been completed.

It has been explained that sometimes the researchers find it helpful to use my own words when writing up the findings of this research. I understand that any use of my words would be completely anonymous (without my name). I have been told that I can decide whether I permit my words to be used in this way.

I hereby fully and freely consent to participate in the study which has been fully explained to me.

Having given this consent I understand that I have the right to withdraw from the programme at any time without disadvantage to myself and without being obliged to give any reason.

I also understand that my participation is voluntary, that I can choose not to participate in part or all of the project and that I can withdraw freely at any stage of the project.

I consent to participate in the investigation into risk management in construction projects within the United Arab Emirates conducted at Bond University. I have read the above Explanatory Statement and I am willing to participate.

Signature of Participant: ________________________ Date: __/__/__

I, the undersigned, was present when the study was explained to the subject/s in detail and to the best of my knowledge and belief it was understood.

Signature of Researcher: ________________________ Date: __/__/__

Appendix 4: Explanatory Statement and Survey Questionnaire

AN INVESTIGATION INTO RISK MANAGEMENT IN CONSTRUCTION PROJECTS WITHIN THE UNITED ARAB EMIRATES
BUHREC No 15806
BOND UNIVERSITY FACULTY OF SOCIETY AND DESIGN

This survey can be completed via a mobile or on a PC but some responses may require textual answers.

I. Introduction and Explanatory Statement

My name is **Mundhir AL hasani** and I am currently completing a **PhD in Risk Management** at **Bond University** under the supervision of **Professor Michael Regan**.

I am conducting a research investigation into risk management in construction projects within the United Arab Emirates. As part of this study, I invite you to participate in a survey and interviews about how to improve risk management practices in the construction sector in the United Arab Emirates (UAE) by exploring stakeholders' practices and perceptions of different aspects of risk management, such as identifying and measuring risk, risk measurement and risk allocation practices, with reference to economic and cultural factors in construction projects in the UAE.

Understanding stakeholders' risk management practices is important because correctly assessing risk is a key element for project success. This is increasingly important in countries such as the UAE, where there are many ongoing and costly building projects with high levels of risk. Exploring the best practice requirements of UAE construction projects will allow for a better understanding of how risk management practices can be used in the construction sector in the UAE to ensure project success. When this research is concluded, this research may help managers and contractors manage construction projects according to the situation and mitigate the risks as much as possible in the UAE and countries with similar risks. Also this research will inform future risk management practices in the UAE.

By using questionnaires (filled out by contractors, clients and consultants), the risks that influence construction projects in the UAE will be identified and ranked. The questionnaires will be used to identify the significance of different aspects of risk management in the UAE construction industry with reference to economic and cultural factors.

Your participation is very much appreciated. The survey should take approximately 25-35 minutes to complete and can be done at your convenience any time before 20 January 2017.

In addition to completing the questionnaires, some of the participants will be asked to take part in an interview. Once the problem is identified and measured through these questionnaires, interviews will be conducted with selected contractors, clients and consultants in order to explore aspects of risk management more profoundly through their lived experiences. Information from the interviewees will be very useful in the analysis of this research work.

The interview will take approximately one hour. The research work is purely for academic purposes and any information you provide will be confidential. Brief quotations from the interview may be used in my thesis but will not be attributed to you individuals and your anonymity will be observed.

Individual details and responses will be held in the STRICTEST CONFIDENCE. No findings that could identity any specific project, individual participant or organisation will be published. Only the combined results of all the participants will be published. A sample of respondents may be contacted for data validation. Providing any project names, personal details and/or organisational information is optional. Any identifying information that is provided will not be published.

Participants will be provided with a summary of the results on request. Please do not hesitate to contact me if you would like to discuss the information provided or ask any questions before agreeing to take part in the study.

Many thanks for taking the time to read this information.
Yours sincerely,

Mundhir AL hasani
Telephone: +61 (07) 5595 0161
Mobile: +61 447 333 090
Email: M.alhasani@student.bond.edu.au
Student Investigator – Mundhir AL hasani
Supervisor – Professor Michael Regan

Should you have any concerns with regards to the conduct or nature of this research, please feel free to contact:
Bond University Human Research Ethics Committee,
Bond University Office of Research Services.
Bond University, Gold Coast, 4229, Australia
Tel: +61 7 5595 4194 Fax: 07 5595 1120 email: ethics@bond.edu.au

II. Questions 1-16: Respondent's Profile.

Q1 Please indicate your job title:

- ❍ Client (Employer, Manager, Client's representative)
- ❍ Contractor (Chief director, Project manager, Site manager, Technical manager)
- ❍ Consultant (Chief director, Project manager, Designer, Superintendent, Specialist engineer)

Q2 How long have you been in this role?

- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q3 Gender:

- ❍ Male
- ❍ Female

Q4 What is your nationality? (citizenship as in your passport):

- ❍ Asian
- ❍ Emirati
- ❍ European
- ❍ Middle Eastern
- ❍ North American
- ❍ South American
- ❍ Other (s) (please specify) ____________________

Q5 How long have you lived in the UAE?

- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q6 How long have you worked in the UAE?

- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q7 What language(s) do you speak at work?

- ❍ Arabic
- ❍ Chinese
- ❍ English
- ❍ French
- ❍ German
- ❍ Indian
- ❍ Italian
- ❍ Japanese
- ❍ Other(s) (please specify) ____________________

Q8 What is the highest level of education you have completed to date?
- ❍ Diploma
- ❍ Graduate certificate/diploma
- ❍ Bachelor's degree
- ❍ Master's degree
- ❍ PhD
- ❍ Other(s) (please specify) ____________________

Q9 Where did you do most of your formal study?
- ❍ Asia
- ❍ Europe
- ❍ Middle East
- ❍ North America
- ❍ South America
- ❍ UAE
- ❍ Other(s) (please specify) ____________________

Q10 Have you received any formal training in risk management practices?
- ❍ Yes
- ❍ No

Q11 How many years of experience do you have in the construction industry?
- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q12 What does your experience of construction project types include?
- ❍ Building
- ❍ Housing
- ❍ Industrial
- ❍ Infrastructure/Heavy Engineering
- ❍ Other(s) (please specify) ____________________

Q13 Do you have formal project management qualifications?
- ❍ Yes
- ❍ No

Q14 How many years of experience do you have in project management?
- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q15 How many years of experience have been involved in the decision-making process about whether or not to proceed with construction projects?

- ❍ 5 years or less
- ❍ 6-10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ 21 years or more

Q16 Have you ever worked on a construction project in a country other than the UAE?

- ❍ Yes
- ❍ No

III. Questions 17-28: Company Profile.

Q17 Your company is?

- ❍ International
- ❍ Government owned
- ❍ Private
- ❍ Public

Q18 What are the key activities of your organization?

- ❍ Building
- ❍ Housing
- ❍ Industrial
- ❍ Infrastructure/heavy engineering
- ❍ Other(s) (please specify) ____________________

Q19 How many expert risk managers does your organisation have?

- ❍ No risk manager
- ❍ One
- ❍ More than one

Q20 In your organisation, is there interaction between expert risk management team and other professional employees?

- ❍ No interaction at all
- ❍ Weak interaction
- ❍ Some interaction
- ❍ Strong interaction
- ❍ Very strong interaction

Q21 Does your company have a risk management strategy to managing risk for construction projects?

- ❍ Yes, implemented
- ❍ Yes, but needs improvement
- ❍ No, but have plans to develop one
- ❍ No

Q22 Are you satisfied with the prevailing risk management strategy of your company?

- Not satisfied at all
- Slightly satisfied
- Somewhat satisfied
- Strongly satisfied
- Very strongly satisfied

Q23 in your opinion, does the company you work for regard itself as having a risk-taking or risk-averse culture in comparison to its relevant competitors?

- More risk-taking
- Risk similar to competitors
- More risk-averse

Q24 Did you undertake a formal risk assessment process in awarding the contract or tendering for the contract?

- Yes
- No

Q25 Please evaluate the following aspects/features of your project decision-making process.

	Strongly Disagree	Disagree	Somewh at Agree	Agree	Strongly Agree
There is a consistent decision- making methodology applied throughout the company.	❍	❍	❍	❍	❍
The company finds it difficult to identify the main risk for specific projects.	❍	❍	❍	❍	❍
The company finds it difficult to identify the likelihood of risks occurring.	❍	❍	❍	❍	❍
The company finds it difficult to assess the impacts of risks materialising.	❍	❍	❍	❍	❍
The company relies on external advice to assess risk.	❍	❍	❍	❍	❍

Q26 Who are the key decision-makers in dealing with risks in your organisation/projects?

- Chief director
- Project manager
- Technical manager
- Engineer
- Other (s) (Please specify) ____________________

Q27 Do you generally implement risk management in your organisation/projects?

- Yes
- No
- Not sure

Q28 Rate the quality of risk management analysis and planning within your company?

- Poor
- Good
- Excellent

Q29 **Construction Risk.** The criticality of a risk refers to the extent the risk affects the success of managers in carrying out a construction project. Please rate the importance of each risk by circling a suitable figure: (Scale: 1 = Not critical at all, 2 = Slightly critical, 3 = Somewhat critical, 4 = Critical, 5 = Very critical).

Risk	1	2	3	4	5
1. Corruption: Corrupt government officials demand bribes or unjust rewards	❍	❍	❍	❍	❍
2. Change in Law: Government's inconsistent application of new regulations and laws	❍	❍	❍	❍	❍
3. Environmental Protection: Stringent regulation which will have an impact on construction firms' poor attention to environmental issues	❍	❍	❍	❍	❍
4. Site Safety: High rate of accidents during construction or operation phases	❍	❍	❍	❍	❍
5. Cash flow: Foreign exchange liquidity, financial soundness	❍	❍	❍	❍	❍
6. Foreign exchange and convertibility: Fluctuation in currency exchange rate and/or difficulty in converting currencies	❍	❍	❍	❍	❍
7. Inflation and interest rate: Unanticipated inflation and interest rate changes	❍	❍	❍	❍	❍
8. Cost overrun: Unavailability of sufficient cash flow, inadequate measurement and pricing of bills of quantities, poorly planned schedule	❍	❍	❍	❍	❍
9. Low construction productivity: Obsolete technology and management practices and low labour productivity of local workforce	❍	❍	❍	❍	❍
10. Late payment: Client pays the contractors much later than scheduled	❍	❍	❍	❍	❍
11. Inadequate project management: Inadequate project planning, budgeting, inadequate organisational structure or a lack of competency in the local project team	❍	❍	❍	❍	❍
12. Market demand: Inadequate forecast about market demand	❍	❍	❍	❍	❍
13. Cultural differences: Differences in work culture, education and values between project stakeholders	❍	❍	❍	❍	❍
14. Human resources: Facing difficulties in hiring and retaining valued and valuable employees	❍	❍	❍	❍	❍
15. Inadequate Design: Unanticipated design changes and errors in design/drawings	❍	❍	❍	❍	❍

Q30 **Economic Factors.** Please rate the extent to which extent the following aspects of economic factors affect the success of construction projects. Use a scale of 1 to 5 where 1= no extent, 2= little extent, 3= moderate extent, 4= large extent and 5 is to a very large extent.

Economic Factors	1	2	3	4	5
Examining the financial resources liability/employer's financial viability	❍	❍	❍	❍	❍
Reviewing the contract properly to allocate extra budget in the bidding phase	❍	❍	❍	❍	❍
Measuring and pricing bills of quantities properly during the bidding phase	❍	❍	❍	❍	❍
Developing a clear and appropriate plan and controlling schedule and cost	❍	❍	❍	❍	❍
Having clear contractual terms and conditions, agreeing on accounting standards and clearly defining authority and responsibility	❍	❍	❍	❍	❍
Employing reputable third party consultants to forecast market demand	❍	❍	❍	❍	❍
Provision of sufficient resources as and when required	❍	❍	❍	❍	❍
Use of efficient project-specific technology	❍	❍	❍	❍	❍
Good project resource planning and controlling	❍	❍	❍	❍	❍
Good financial accountability and management	❍	❍	❍	❍	❍
Effects of the exchange rate on acquisition of resources	❍	❍	❍	❍	❍
Efficient/timely procurement of materials and equipment	❍	❍	❍	❍	❍
Good forecasting of work plan/ estimation project duration	❍	❍	❍	❍	❍
Monitoring and Evaluation can lead to timely implementation of projects	❍	❍	❍	❍	❍

Q31 **Cultural Factors.** Please evaluate the following statement about aspects/features of cultural factors.

Cultural Factors	Strongly Disagree	Disagree	Somewhat disagree	Agree	Strongly agree
Emiratis value personal trust as an important ingredient in business transactions.	❍	❍	❍	❍	❍
Emiratis prefer to do business face to face.	❍	❍	❍	❍	❍
Emiratis like to get to know the person they are doing business with before they do business.	❍	❍	❍	❍	❍
Attitudes to time in many Western countries are much more relaxed than in the UAE.	❍	❍	❍	❍	❍
There is a strong vertical hierarchy structure in most Emirate companies.	❍	❍	❍	❍	❍
The system of communication about the nature of risks within the organisation is effective.	❍	❍	❍	❍	❍
The system of communication about risk mitigation strategies within the organisation is effective.	❍	❍	❍	❍	❍
There is a large communication gap between the contractor and the client.	❍	❍	❍	❍	❍
There is a large communication gap between the contractor and the consultant.	❍	❍	❍	❍	❍
There is a large communication gap between the contractor and the employees.	❍	❍	❍	❍	❍
The manager does not have enough experience in project management.	❍	❍	❍	❍	❍
The contractor does not have sufficient similar work experience.	❍	❍	❍	❍	❍
Emirati contractors urgently need risk management knowledge and expertise in managing construction projects.	❍	❍	❍	❍	❍
Various languages affect the project.	❍	❍	❍	❍	❍
Various educational backgrounds affect the project.	❍	❍	❍	❍	❍
Different ways of thinking affects the project.	❍	❍	❍	❍	❍
Various decision-making processes affect the project.	❍	❍	❍	❍	❍
Stakeholder engagement is important in the project.	❍	❍	❍	❍	❍
Dispute resolution is important in the project.	❍	❍	❍	❍	❍

Q32 How would you rate the influence of economic factors on the success of projects in construction?

❍ Very strong
❍ Strong
❍ Somewhat strong
❍ Not strong

Q33 How would you rate the influence of cultural factors on the success of projects in construction?

❍ Very strong
❍ Strong
❍ Somewhat strong
❍ Not strong

Q34 **Risk Management Processes**. Please evaluate the following aspects/features of your risk management process.

	Yes	Yes, but needs improvement	No	Do not Know
The company's structure supports effective risk management	❍	❍	❍	❍
The company's culture supports effective risk management	❍	❍	❍	❍
Reporting and communication processes between staff and top management supports the effective management of risk	❍	❍	❍	❍
Roles, responsibilities and accountabilities are clearly defined	❍	❍	❍	❍
There are clear and written management statements on risk management	❍	❍	❍	❍
The company's senior management is receptive to all communications about risk, including bad news	❍	❍	❍	❍
There is adequate risk management training provided to management and other personnel in order to ensure that adequate capabilities exist within the business	❍	❍	❍	❍
The responsibilities for the risk management of the project and continuous monitoring of risk are clearly defined	❍	❍	❍	❍
A functional reporting concept has been designed and fully implemented	❍	❍	❍	❍

IV. **Project Outcomes** (Note that the project needs to have been completed within the last two years). Questions (35-40) relate to the success of the project. Please respond to these by denoting the most applicable response.

Q35 The project's objectives were met?
❍ Mostly
❍ Partially
❍ Very little
❍ Not at all

Q36 The project's was delivered on schedule?
❍ Yes
❍ No

Q37 The project's was delivered on budget?
❍ Yes
❍ No

Q38 The project's scope was achieved?
❍ Mostly
❍ Partially
❍ Very little
❍ Not at all

Q39 The project's quality objectives were met?
❍ Mostly
❍ Partially
❍ Very little
❍ Not at all

Q40 How would you rate the level of client satisfaction with respect to the delivery of the project?

- ❍ High
- ❍ Moderate
- ❍ Low
- ❍ Very Low

Q41 Are you willing to participate in Interview?

- ❍ Yes
- ❍ No

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix 5: Goodness of Fit Indices

A5.1 Introduction

An evaluation of model fit for a statistical model is important to appreciate its GOF in terms of describing the available data and data sample (Bustamante & Chacon, 2016; Hooper *et al*., 2008; Mulaik *et al*., 1989; Schermelleh-Engel *et al*., 2003). Therefore, the proper consideration of the model fit is an essential part of statistical data analysis and modelling.

The analysis of model fit for a simple linear regression is usually straightforward and involves the evaluation of the R^2 coefficient and considerations of applicability of the linear regression model to the data sample. Further, the evaluation of model fit for the CFA and/or structural equation model is more complex. In this case, model fit could and should be considered from different angles using a variety of statistical methods to evaluate the fit and suitability of specific elements or aspects of the model. Currently, there is no single statistical test that can be used for the comprehensive evaluation of fit of CFA and/or SEM models (Schermelleh-Engel *et al*., 2003).

Current statistical techniques for the evaluation of fit of CFA and SEM models are based on the calculation and evaluation of GOF indices. Each index provides information about specific characteristics of the model fit. Further, neither of the GOF indices can comprehensively evaluate the fit or the model; thus, several GOF indices must be considered simultaneously to ensure proper and adequate evaluation of the models and their suitability for the analysis of the available data sample (Bustamante & Chacon, 2016; Hooper *et al*., 2008; Schermelleh-Engel *et al*., 2003; Wolf *et al*., 2013).

Importantly, GOF indices may vary substantially depending on the sample size, number of variables and number of degrees of freedom in the problem and the statistical methods used (Hu & Bentler, 1999). This introduces a degree of uncertainty in the interpretation of the evaluation outcomes based on GOF indices, which must always be considered when considering GOF indices for any particular model. Therefore, efforts have been made to develop GOF indices that are as least susceptible to these problems as possible (Hooper *et al*., 2008; Hu & Bentler, 1999). Further, it is important to use several GOF indices with a different nature simultaneously and to evaluate different aspects of the model fit to obtain more reliable and less limited evaluations (Bustamante & Chacon, 2016; Jaccard & Wan, 1996).

A5.2 χ-square Statistic (Test)

The χ-square statistic is one of the most important and informative GOF indices that should always be considered for a CFA or SEM model. This index is the only one related to a significance test (Bustamante & Chacon, 2016; Schermelleh-Engel *et al*., 2003), thus producing a p-value suitable for a quantitative evaluation of the probability that the model is correct and valid. Other GOF indices only produce descriptive outcomes, which means that a quantitative evaluation of the level of statistical significance of a particular model is not possible or is at least difficult.

The χ-square statistic evaluates the differences between the elements of the population and model-implied covariance matrices (Schermelleh-Engel *et al*., 2003) and tests whether the differences are essentially zero. Roughly speaking, the χ-square statistic tests whether there is a significant difference between the considered and perfect models. If any of the tested differences are significant, the developed model may have unacceptable fit to the sample data. A *p*-value resulting from the χ-square test for a model is the probability that there is no difference between the elements of the population and model-implied covariance matrices (Schermelleh-Engel *et al*., 2003)—that is, the probability that the model has a perfect fit. The χ-square statistic tests for *no difference* between the developed and perfect models; therefore, the rules for *p*-values required for good model fit contrast with what is usually required for the good fit of a simple linear regression model. Namely, larger *p*-values for the χ-square test correspond to a better model fit. In this case, the *p*-value is the probability that the developed model is the perfect model. An acceptable fit is achieved for a model if the χ-square *p*-value is greater than the conventional cut-off value of 0.05.

The χ-square statistic is sensitive to the level of complexity of the model—that is, the larger the number of degrees of freedom (*df*) for the model (i.e., the number of variables and relationships between them), the larger the value of χ^2. To reduce this dependence, relative χ-square, χ^2/df is typically used. Typically, the smaller the value of χ^2/df, the better the model fit. Different literature sources suggest different conventional cut-off values for χ^2/df, which means that the model fit can be regarded as acceptable. It is often regarded that χ^2/df should be < 2 (Ullman *et al*., 2001) or five (Schumacker & Lomax, 2012).

However, because of the significant sensitivity of the χ-square statistic (and even its relative version χ^2/df) on the sample size and the complexity of the model (Bustamante & Chacon, 2016; Hair *et al*., 1995; Mulaik *et al*., 1989), its value for the accurate evaluation of the model fit may be somewhat confusing, with conventional cut-off values varying significantly in the literature (Schumacker & Lomax, 2012; Ullman *et al*., 2001). Therefore, the actual value of the χ-square statistic is significantly less important than the respective *p*-values determining the statistical significance of the developed model (and the obtained χ-square values, irrespective of their actual values). Accordingly, the actual values of the χ-square statistic are often not used at all in the presentation of model fit, but only the respective *p*-values. In addition, an applicability condition for the χ-square test is that the involved variables must be distributed normally.

Given the indicated difficulties with the χ-square test and its primary reliance on the comparison of the population and model-implied covariance matrices (Schermelleh-Engel *et al*., 2003), other GOF indices should also be used for more reliable evaluation of the model fit. These other GOF indices include:

- root mean square error of approximation (RMSEA),
- standardised root mean square residual (SRMR),
- coefficient of determination (CD),
- comparative fit index (CFI) and
- Tucker-Lewis index (TLI).

These are typically regarded as the most important GOF indices for evaluating the proper determination of fit of CFA and SEM models. Therefore, these indices are described in detail in this appendix.

A5.3 Root Mean Square Error of Approximation

RMSEA can be regarded as an index of 'badness of fit' because it illustrates the level of inadequacy of the model to the population data (Bustamante & Chacon, 2016; Hooper *et al*., 2008; Steiger, 1990; Wolf *et al*., 2013). Given that it is evaluated per one degree of freedom of the model, it is automatically corrected for model complexity. This is a significant advantage of RMSEA, which does not make it entirely immune to the effects associated with the increasing number of variables and relationships in the model (Steiger, 1990). RMSEA is simply less sensitive to these issues compared with the χ-square statistic, but it has approximately the same sensitivity to model complexity as the relative χ-square statistic χ^2/df. The typical ranges of RMSEA conventionally accepted for the evaluation of the model fit are (Bustamante & Chacon, 2016; MacCallum *et al*., 1996): RMSEA < 0.01 (excellent fit); 0.01 ≤ RMSEA ≤ 0.05 (good fit); 0.05 < RMSEA ≤ 0.08 (reasonable fit); 0.08 < RMSEA ≤ 0.10 (mediocre fit); and RMSEA > 0.10 (typically unacceptable model fit). It is important to note that these ranges should only be regarded as indications of the model fit, and consideration of other GOF indices is essential.

A5.4 Standardised Root Mean Square Residual

SRMR is also regarded as an index of 'badness of fit'. This is because the perfect model fit corresponds to SRMR = 0, and model fit becomes worse with an increasing value of SRMR, which is calculated as the square root of the mean of the squared fitted residuals for the standardised variables. The use of standardised variables is important to eliminate the effect of the scale of non-standardised variables involved in the model. Variables with a larger scale typically have larger absolute fluctuations and larger fitted residuals, whereas standardisation of the variables reduces them to the same scale and, thus, directly comparable residuals. Nonetheless, SRMR still depends on the sample size, and it is sensitive to misspecification of the model (Hu & Bentler, 1999). Conventionally, SRMR ≤ 0.05 is regarded as corresponding to a good fit (Hu & Bentler, 1999) and SRMR > 0.10 might be considered unacceptable. However, once again, these ranges should only be regarded as indications of the level of model fit based on SRMR, and consideration of other GOF indices is essential.

A5.5 Coefficient of Determination

CD is also called the GOF index (GFI), which determines the portion of the total variance of endogenous variables that can be explained by the developed model (Bustamante & Chacon, 2016; Hooper *et al*., 2008; Tabachnick & Fidell, 2007; Wolf *et al*., 2013). Endogenous variables are defined as those that are affected by any other variables in the model (a kind of dependent variable). The GFI index takes values between 0 and 1, with larger values indicating better model fit or better efficiency of the model in explaining the total variance of endogenous variables.

However, a perception that larger values of CD correspond to better model fit may be misleading about the adequacy or otherwise of the developed model. Small values are not necessarily a consequence of an inadequately developed model, but may reflect the fact that not all important variables or factors have been considered by the data and the developed model. The model may adequately describe the variables and factors, and it may be very good in terms of explaining the effects of these variables and factors. However, these variables may only be responsible for a small portion of the total variance of the endogenous variables, while the rest of the variance may be caused by additional variables and factors not included in the model. In this sense, low CD values may indicate incompleteness of the developed model rather than its inadequacy or failure.

Even if the CD values are small, this should not necessarily be regarded as bad model fit. The model might still be good in terms of its ability to adequately describe the effects of the variables and/or factors if the other GOF indices indicate good model fit. In this case, small CD values should be attributed to the incompleteness of the model rather than its bad fit.

A5.6 Comparative Fit Index and Tucker-Lewis Index

Another type of GOF index is based on comparative index measures. In this case, the developed model is compared with a baseline model with no relationships between the observed variables (the variables are assumed not to be correlated). This category of GOF index includes the normed fit index (NFI) and CFI. The values of these indices can vary between 0 and 1, with larger values corresponding to a better model fit (Schermelleh-Engel *et al*., 2003). It is typically assumed that good model fit has been achieved if NFI ≥ 0.95 and CFI ≥ 0.97, while acceptable model fit typically corresponds to NFI ≥ 0.90 and CFI ≥ 0.95 (Marcoulides & Yuan, 2017; Marsh & Grayson, 1995; Schumacker & Lomax, 2012).

Unlike CFI, which only weakly depends on sample size (Barclay *et al*., 1995), NFI is more sample-sensitive. As a result, further improvements to NFI were made, and the improved index was called the TLI. Good fit relative to the independence model is conventionally achieved in which TLI $\geq$ 0.97, while acceptable model fit conventionally corresponds to TLI $\geq$ 0.95 (Schermelleh-Engel *et al*., 2003).

In conclusion, the provided conventional ranges for all GOF indices indicating different levels of model fit are only a rule of thumb. They should only be used with caution and in the understanding that they could be misleading (Hayduk *et al*., 2007), which is particularly relevant when models with different sample sizes and complexity are compared. To avoid potential difficulties and 'mistakes' when interpreting the validity of the models, it is important to use several different GOF indices that reflect different aspects of the model fit and consider them in conjunction with each other. It is also important to use all of the most important and widely accepted GOF indices. Thus, this thesis evaluated the fit of the developed CFA and SEM models based on the following six most frequently used indices: χ-square statistic (the corresponding *p*-value for the model), RMSEA, TLI, CFI, SRMR and CD.

Appendix 6: Interview Questions

AN INVESTIGATION INTO RISK MANAGEMENT IN CONSTRUCTION PROJECTS WITHIN THE UNITED ARAB EMIRATES
BUHREC No 15806
BOND UNIVERSITY FACULTY OF SOCIETY AND DESIGN

1. What is your job title?
    - Client (Employer, Manager, Client's representative)
    - Contractor (Chief director, Project manager, Site manager, Technical manager)
    - Consultant (Chief director, Project manager, Designer, Superintendent, Specialist engineer)
2. What is the nature and size of the projects you are involved with?
3. What do you consider as a "major risk" in the UAE's construction projects?
4. How do you identify and measure risk in UAE construction projects?
5. Every construction project involves risks. From your experience, please identify / list the most important risks that your firm encounters on/with construction projects. Please list all of the risks (up to 20) you have encountered in order of priority.

Priority 1 is highest priority	List of Risks
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

6. How do you manage risk in construction projects in the UAE?
7. What processes does your organisation have for managing/mitigating risks? and why?
8. What decision-making and planning processes have you used to examine organisation/projects risks and why?

9. In your opinion, what could be done to improve risk management practices in construction projects in the UAE?
10. How would you describe risk management performance in the UAE's construction projects, especially with respect to its unique economic and cultural factors?
11. Do you identify economic and cultural factors as a significant influence in the UAE? If yes, please elaborate on your strategies to deal with these factors.
12. Does your organisation identify economic and cultural factors as a significant influence in the UAE? If yes, please elaborate on your strategies to deal with these factors.
13. What are the risk allocation practices in UAE construction contracts?
14. How contractors are usually selected?
15. What risks are typically allocated to the contractor? How are these risks offset or managed?
16. How is your relationship with the contractor/consultant/client? Do they also mitigate the risks or all the existing risks will be shifted under your responsibilities?
17. How are construction projects financed in the UAE?
18. At the end of the project, is there any learning process of what has happened during the project? How?
19. Please feel free to provide me with your opinion about any existing issue in the construction industry in UAE which was not mentioned in this interview.

Thank you very much for your time!

Appendix 7: An Example of Data Outcomes for Models 2 and 3

Survey: Mean estimation (use "C:\Users\Mundhir ALhasani\data10march.dta", clear)

Number of obs = 237

Dependent Constructs

1. RM Practice Outcomes

EFA factor loadings for RM Practice Outcomes construct (Decision Making).
Rotated factor loadings (pattern matrix) and unique variances.

Variable	Factor1	Uniqueness
q25_2	0.5466	0.7012
q25_3	0.6148	0.6220
q25_4	0.5992	0.6410
q25_5	0.4025	0.8380
q34_1	-0.6027	0.6367
q34_2	-0.6181	0.6179

(blanks represent abs(loading)<.3)

Cronbach's alphas for RM Practice Outcomes.

Test scale = mean (unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q25_2	237	+	0.6129	0.3083	.1696131	0.4783
q25_3	237	+	0.6392	0.3243	.1598191	0.4704
q25_4	237	+	0.5446	0.3086	.1917614	0.4798
q25_5	237	+	0.5463	0.2026	.2039834	0.5424
q34_1	237	-	0.5135	0.3446	.2067153	0.4813
q34_2	237	-	0.4864	0.3318	.2163305	0.4906
Test scale					.1913705	0.5361

```
Sem (Decision Making -> q25_2 q25_3 q25_4 q25_5 q34_1 q34_2), ///
method(adf) stand
Endogenous variables
Measurement:  q25_2 q25_3 q25_4 q25_5 q34_1 q34_2
Exogenous variables
Latent:       Decision Making

Fitting baseline model:

Iteration 0:   discrepancy =   .30193261
Iteration 1:   discrepancy =   .18852635
Iteration 2:   discrepancy =   .18852635
Fitting target model:

Iteration 0:   discrepancy =   .04098048
Iteration 1:   discrepancy =   .03234538
Iteration 2:   discrepancy =   .03228732
Iteration 3:   discrepancy =   .03228721
Iteration 4:   discrepancy =   .03228721

Structural equation model                    Number of obs      =      237
Estimation method  = adf
```

```
Discrepancy       =   .03228721

(1)   [q25_2]Decision Making = 1
------------------------------------------------------------------------------------
      Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------+----------------------------------------------------------------
Measurement        |
  q25_2 <-         |
   Decision Making |   .4254618   .0758806     5.61   0.000     .2767385    .5741852
             _cons |   3.084227   .1660167    18.58   0.000      2.75884    3.409614
  -----------------+----------------------------------------------------------------
  q25_3 <-         |
   Decision Making |   .4919781   .0678311     7.25   0.000     .3590316    .6249245
             _cons |   2.705142   .1347908    20.07   0.000     2.440957    2.969327
  -----------------+----------------------------------------------------------------
  q25_4 <-         |
   Decision Making |   .5156414   .0878291     5.87   0.000     .3434996    .6877832
             _cons |    3.97666   .2442351    16.28   0.000     3.497968    4.455352
  -----------------+----------------------------------------------------------------
  q25_5 <-         |
   Decision Making |   .2801042   .0854425     3.28   0.001     .1126399    .4475685
             _cons |   2.453782   .1057195    23.21   0.000     2.246576    2.660989
  -----------------+----------------------------------------------------------------
  q34_1 <-         |
   Decision Making |  -.4731142   .0722133    -6.55   0.000    -.6146496   -.3315789
             _cons |   2.534951   .0874777    28.98   0.000     2.363498    2.706405
  -----------------+----------------------------------------------------------------
  q34_2 <-         |
   Decision Making |  -.5013526   .0673935    -7.44   0.000    -.6334413   -.3692638
             _cons |   2.744302    .106041    25.88   0.000     2.536466    2.952139
-------------------+----------------------------------------------------------------
      var(e.q25_2)|   .8189822   .0645686                      .7017229    .9558358
      var(e.q25_3)|   .7579576   .0667428                      .6378101    .9007379
      var(e.q25_4)|    .734114   .0905766                      .5764218    .9349462
      var(e.q25_5)|   .9215416   .0478656                       .832344    1.020298
      var(e.q34_1)|   .7761629   .0683302                      .6531555    .9223361
      var(e.q34_2)|   .7486456   .0675758                      .6272539    .8935301
var(DecisionMaking)|          1          .                             .           .
------------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(9)   =     7.65, Prob > chi2 = 0.5696

estat gof, stats(all)
```

Model Fit for CFA Models - RM Practice Outcomes.

```
----------------------------------------------------------------------------
Fit statistic|      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(9) |      7.652   model vs. saturated
            p > chi2 |      0.570
         chi2_bs(15) |     44.681   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.065
              pclose |      0.871   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.076   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.037   Standardized root mean squared residual
                  CD |      0.617   Coefficient of determination
----------------------------------------------------------------------------
```

2. Project Success

Cronbach's alpha values for Project Success.

```
factor q35 q38 q39 q40, pcf
rotate, blanks (.3)

alpha q35 q38 q39 q40, item

Factor analysis/correlation                        Number of obs    =      237
    Method: principal-component factors           Retained factors =        1
    Rotation: orthogonal varimax (Kaiser off)      Number of params =        4
    --------------------------------------------------------------------------
         Factor  |     Variance   Difference        Proportion   Cumulative
    -------------+------------------------------------------------------------
        Factor1  |      2.81527            .            0.7038       0.7038
    --------------------------------------------------------------------------
    LR test: independent vs. saturated:  chi2(6)   =  433.96 Prob>chi2 = 0.0000
Rotated factor loadings (pattern matrix) and unique variances

    ---------------------------------------
        Variable |  Factor1 |   Uniqueness
    -------------+----------+--------------
             q35 |   0.7589 |       0.4241
             q38 |   0.8649 |       0.2519
             q39 |   0.8692 |       0.2444
             q40 |   0.8577 |       0.2643
    ---------------------------------------
    (blanks represent abs(loading)<.3)

Factor rotation matrix
    -----------------------
                 | Factor1
    -------------+---------
         Factor1 |  1.0000
    -----------------------

alpha q35 q38 q39 q40, item
```

```
Test scale = mean (unstandardized items)
                                                             average
                              item-test     item-rest       interitem
Item         |  Obs  Sign   correlation   correlation      covariance      alpha
-------------+-----------------------------------------------------------------
q35          |  237    +       0.7735        0.6009        .7332356       0.8605
q38          |  237    +       0.8652        0.7414        .6076903       0.8031
q39          |  237    +       0.8643        0.7456        .6187215       0.8014
q40          |  237    +       0.8485        0.7299        .6576259       0.8094
-------------+-----------------------------------------------------------------
Test scale   |                                             .6543183       0.8583
-------------------------------------------------------------------------------

Sem (Project Success ->  q35 q38 q39 q40), ///
method(adf) stand
estat mindices
estat gof, stats(all)

note: The following observed variable name will be treated as a latent variable: Q18.  If this is not your
intention use the nocaps latent option, or identify the latent variable names in the latent () option.

Endogenous variables

Measurement:  q35 q38 q39 q40
Exogenous variables

Latent:       Project Success

Fitting baseline model:

Iteration 0:   discrepancy =   2.1127173
Iteration 1:   discrepancy =   .68040972
Iteration 2:   discrepancy =   .68040972

Fitting target model:

Iteration 0:   discrepancy =   .00783969
Iteration 1:   discrepancy =   .00598478
Iteration 2:   discrepancy =   .00598387
Iteration 3:   discrepancy =   .00598387

Structural equation model                       Number of obs      =        237
Estimation method  = adf
Discrepancy        = .00598387
```

```
(1)   [q35]Project Success = 1
-----------------------------------------------------------------------------------
      Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------+---------------------------------------------------------------
Measurement        |
  q35 <-           |
    ProjectSuccess |   .6487312   .0444127    14.61   0.000     .5616839    .7357785
             _cons |   1.058973   .0546049    19.39   0.000     .9519498    1.165997
  -----------------+---------------------------------------------------------------
  q38 <-           |
    ProjectSuccess |   .8243623   .0340379    24.22   0.000     .7576493    .8910754
             _cons |   1.262991   .0695675    18.15   0.000     1.126641    1.399341
  -----------------+---------------------------------------------------------------
  q39 <-           |
    ProjectSuccess |   .8429632   .0318411    26.47   0.000     .7805558    .9053705
             _cons |   1.142552   .0623316    18.33   0.000     1.020384     1.26472
  -----------------+---------------------------------------------------------------
  q40 <-           |
    ProjectSuccess |   .8046932   .0424591    18.95   0.000     .7214749    .8879115
             _cons |   1.203473   .0637827    18.87   0.000     1.078462    1.328485
-------------------+---------------------------------------------------------------
        var(e.q35)|   .5791478   .0576238                      .4765373     .703853
        var(e.q38)|   .3204268   .0561191                      .2273267    .4516553
        var(e.q39)|   .2894131   .0536817                      .2012025    .4162968
        var(e.q40)|   .3524689   .0683331                      .2410452    .5153984
var(ProjectSuccess)|          1          .                             .           .
-----------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(2)   =     1.42, Prob > chi2 = 0.4921

Model Fit for CFA Models  - Project Success.
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(2) |      1.418   model vs. saturated
            p > chi2 |      0.492
          chi2_bs(6) |    161.257   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.116
              pclose |      0.664   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.011   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.010   Standardized root mean squared residual
                  CD |      0.877   Coefficient of determination
----------------------------------------------------------------------------
```

<u>Independent Constructs</u>

1. <u>Risk Management (RM) Practices items Q20 - Q22.</u>

```
Sem (RM Practices ->  q20 q21 q22), ///
> method(adf) stand

Endogenous variables

Measurement:  q20 q21 q22

Exogenous variables
```

```
Latent:       RM Practices

Fitting baseline model:

Iteration 0:   discrepancy =   .33982108
Iteration 1:   discrepancy =   .24637462
Iteration 2:   discrepancy =   .24637462  (backed up)

Fitting target model:

Iteration 0:   discrepancy =   1.730e-31
Iteration 1:   discrepancy =  1.338e-33

Structural equation model                       Number of obs     =        237
Estimation method  = adf
Discrepancy        =  1.338e-33

(1)  [q20]RM Practices = 1
------------------------------------------------------------------------------
   Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
Measurement     |
  q20 <-        |
    RMPractices |   .4916834   .0693199     7.09   0.000     .3558188     .627548
          _cons |   .7317609   .0443256    16.51   0.000     .6448844    .8186375
  --------------+-------------------------------------------------------------
  q21 <-        |
    RMPractices |   .5589702   .0964128     5.80   0.000     .3700046    .7479358
          _cons |   .7680886   .0502842    15.27   0.000     .6695333    .8666439
  --------------+-------------------------------------------------------------
  q22 <-        |
    RMPractices |   .6560964    .100838     6.51   0.000     .4584576    .8537352
          _cons |   .8222979   .0493893    16.65   0.000     .7254967    .9190992
----------------+-------------------------------------------------------------
      var(e.q20)|   .7582474   .0681669                       .6357515    .9043457
      var(e.q21)|   .6875523   .1077838                       .5056705    .9348543
      var(e.q22)|   .5695375   .1323189                       .3612146    .8980062
var(RMPractices)|          1          .                              .           .
------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(0)    =      0.00, Prob > chi2 = 0.000
. estat gof, stats(all)

Model Fit for CFA Models  - Risk Management (RM) Practices.
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(0) |      0.000   model vs. saturated
            p > chi2 |          .
          chi2_bs(3) |     58.391   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.000
              pclose |      1.000   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.000   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.000   Standardized root mean squared residual
                  CD |      0.605   Coefficient of determination
----------------------------------------------------------------------------
```

Cronbach's alpha values for Risk Management (RM) Practices.

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q20	237	+	0.7960	0.3613	.4529607	0.5367
q21	237	+	0.6911	0.3814	.5693521	0.4650
q22	237	+	0.7176	0.4231	.4856433	0.4104
Test scale					.502652	0.5647

2. External Risks: Q29.1, Q29.2, Q29.12 and Q29.13.

```
Sem (External Risk ->  q29_1 q29_2 q29_12 q29_13), ///
> method(adf) stand

Endogenous variables
Measurement:  q29_1 q29_2 q29_12 q29_13
Exogenous variables
Latent:       External Risk

Fitting baseline model:

Iteration 0:   discrepancy =   .35471926
Iteration 1:   discrepancy =   .1152819
Iteration 2:   discrepancy =   .1152819

Fitting target model:

Iteration 0:   discrepancy =   .00768333
Iteration 1:   discrepancy =   .00592147
Iteration 2:   discrepancy =   .00591377
Iteration 3:   discrepancy =   .00591377

Structural equation model                    Number of obs     =       237
Estimation method  = adf
Discrepancy        = .00591377

(1)  [q29_1]External Risk = 1
```

Standardized	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Measurement						
q29_1 <-						
ExternalRisk	.6525984	.0727379	8.97	0.000	.5100346	.7951621
_cons	3.889091	.2601297	14.95	0.000	3.379246	4.398936
q29_2 <-						
ExternalRisk	.4811143	.0797391	6.03	0.000	.3248286	.6374
_cons	4.128102	.2881279	14.33	0.000	3.563382	4.692822
q29_12 <-						
ExternalRisk	.7010042	.0852955	8.22	0.000	.5338281	.8681803
_cons	4.796925	.3622404	13.24	0.000	4.086946	5.506903
q29_13 <-						
ExternalRisk	.3902158	.0937018	4.16	0.000	.2065637	.5738679
_cons	4.168289	.2694556	15.47	0.000	3.640165	4.696412
var(e.q29_1)	.5741153	.0949373			.4151854	.7938825
var(e.q29_2)	.7685291	.0767272			.6319451	.9346333
var(e.q29_12)	.5085931	.119585			.3207955	.8063297
var(e.q29_13)	.8477316	.0731278			.7158652	1.003889
var(ExternalRisk)	1	.			.	.

Discr. test of model vs. saturated: chi2(2) =   1.40, Prob > chi2 = 0.4962

Model Fit for CFA Models - External Risk.

```
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(2) |      1.402   model vs. saturated
            p > chi2 |      0.496
          chi2_bs(6) |     27.322   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.116
              pclose |      0.667   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.084   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.025   Standardized root mean squared residual
                  CD |      0.686   Coefficient of determination
----------------------------------------------------------------------------
```

Cronbach's alpha values for External Risk.
alpha q29_1 q29_2 q29_12 q29_13, item

```
Test scale = mean(unstandardized items)
                                                            average
                              item-test     item-rest      interitem
Item         |  Obs  Sign    correlation   correlation     covariance      alpha
-------------+-------------------------------------------------------------------
q29_1        |  237    +       0.7267        0.4457        .2478426       0.5251
q29_2        |  237    +       0.6728        0.3867        .2937376       0.5694
q29_12       |  237    +       0.7269        0.4968        .2486412       0.4955
q29_13       |  237    +       0.6252        0.3066        .3382321       0.6277
-------------+-------------------------------------------------------------------
Test scale   |                                             .2821134       0.6257
---------------------------------------------------------------------------------
```

3. Internal Risks: Q29.4, Q29.11, Q29.14 and Q29.15.

```
. sem (Internal Risk ->  q29_4 q29_11 q29_14 q29_15), ///
> method(adf) stand

Endogenous variables
Measurement:  q29_4 q29_11 q29_14 q29_15

Exogenous variables

Latent:       Internal Risk

Fitting baseline model:

Iteration 0:   discrepancy =   1.5182569
Iteration 1:   discrepancy =   .52970281
Iteration 2:   discrepancy =   .52970281   (backed up)

Fitting target model:

Iteration 0:   discrepancy =   .02401456
Iteration 1:   discrepancy =   .01699213
Iteration 2:   discrepancy =   .01695506
Iteration 3:   discrepancy =   .01695506

Structural equation model                      Number of obs     =        237
Estimation method  = adf
Discrepancy        =  .01695506
```

(1) [q29_4]Internal Risk = 1

Standardized	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Measurement						
q29_4 <-						
InternalRisk	.7913646	.0439916	17.99	0.000	.7051426	.8775867
_cons	3.431147	.1440049	23.83	0.000	3.148902	3.713391
q29_11 <-						
InternalRisk	.5852139	.0560572	10.44	0.000	.4753439	.695084
_cons	2.325598	.1008983	23.05	0.000	2.127841	2.523355
q29_14 <-						
InternalRisk	.6949793	.0446313	15.57	0.000	.6075036	.7824549
_cons	2.262375	.1138774	19.87	0.000	2.039179	2.48557
q29_15 <-						
InternalRisk	.7207976	.0452395	15.93	0.000	.6321298	.8094655
_cons	3.145014	.1689769	18.61	0.000	2.813826	3.476203
var(e.q29_4)	.373742	.0696269			.2594155	.5384531
var(e.q29_11)	.6575246	.0656109			.5407234	.799556
var(e.q29_14)	.5170038	.0620356			.4086557	.6540786
var(e.q29_15)	.4804508	.0652171			.3682184	.6268913
var(InternalRisk)	1	.			.	.

Discr. test of model vs. saturated: chi2(2) = 4.02, Prob > chi2 = 0.1341

Model Fit for CFA Models - Internal Risk.

Fit statistic	Value	Description
Discrepancy		
chi2_ms(2)	4.018	model vs. saturated
p > chi2	0.134	
chi2_bs(6)	125.540	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.065	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	0.159	
pclose	0.291	Probability RMSEA <= 0.05
Baseline comparison		
CFI	0.983	Comparative fit index
TLI	0.949	Tucker-Lewis index
Size of residuals		
SRMR	0.032	Standardized root mean squared residual
CD	0.808	Coefficient of determination

Cronbach’s alpha values for Internal Risk.
alpha q29_4 q29_11 q29_14 q29_15, item
Test scale = mean (unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q29_4	237	+	0.7941	0.6551	.7998343	0.6831
q29_11	237	+	0.7255	0.4849	.851385	0.7600
q29_14	237	+	0.8128	0.5998	.6721793	0.7011
q29_15	237	+	0.7642	0.5806	.8041252	0.7083
Test scale					.781881	0.7683

4. Financial Risks: Q29.5 - Q29.8, Q29.10 and Q30.11.

Cronbach's alpha values for Financial Risks.

```
alpha q29_5 q29_6 q29_7 q29_8 q29_10 q30_11, item
. alpha q29_5 q29_6 q29_7 q29_8 q29_10 q30_11, item

Test scale = mean (unstandardized items)
                                                            average
                                  item-test     item-rest     interitem
Item          |  Obs  Sign   correlation   correlation    covariance      alpha
--------------+-----------------------------------------------------------------
q29_5         |  237    +        0.6143        0.4127       .4062451     0.6817
q29_6         |  237    +        0.6166        0.4428       .4126493     0.6740
q29_7         |  237    +        0.6125        0.4281       .4115676     0.6774
q29_8         |  237    +        0.6324        0.4643       .4060699     0.6684
q29_10        |  237    +        0.6908        0.4582       .3531038     0.6721
q30_11        |  237    +        0.6818        0.4785       .3643943     0.6612
--------------+-----------------------------------------------------------------
Test scale    |                                            .3923383     0.7114
--------------------------------------------------------------------------------
Sem (Fin1 ->  q29_5 q29_6 q29_7 q29_8 q29_10 q30_11), ///
method(adf) stand

estat mindices
estat gof, stats(all)

. sem(Fin1 ->  q29_5 q29_6 q29_7 q29_8 q29_10 q30_11), ///
> method(adf) stand
note: The following observed variable name will be treated as a latent variable: Q18.  If this is not your
intention use the nocaps latent option, or identify the latent variable names in the latent () option.

Endogenous variables

Measurement:  q29_5 q29_6 q29_7 q29_8 q29_10 q30_11

Exogenous variables

Latent:       Fin1

Fitting baseline model:

Iteration 0:   discrepancy =   .60353727
Iteration 1:   discrepancy =   .31165297
Iteration 2:   discrepancy =   .31165297

Fitting target model:

Iteration 0:   discrepancy =   .04384858
Iteration 1:   discrepancy =   .03042592
Iteration 2:   discrepancy =   .02986974
Iteration 3:   discrepancy =   .02986704
Iteration 4:   discrepancy =   .02986704

Structural equation model                         Number of obs      =       237
Estimation method  = adf
Discrepancy        =  .02986704
```

```
(1)   [q29_5]Fin1 = 1
------------------------------------------------------------------------------
Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Measurement  |
  q29_5 <-   |
        Fin1 |    .486855   .0631983     7.70   0.000     .3629886    .6107213
       _cons |   3.556193   .1821738    19.52   0.000     3.199139    3.913247
  -----------+----------------------------------------------------------------
  q29_6 <-   |
        Fin1 |   .5531045   .0648745     8.53   0.000     .4259527    .6802562
       _cons |   4.018308   .2573494    15.61   0.000     3.513913    4.522704
  -----------+----------------------------------------------------------------
  q29_7 <-   |
        Fin1 |   .5368594   .0620404     8.65   0.000     .4152623    .6584564
       _cons |   3.983548   .3078841    12.94   0.000     3.380106    4.586989
  -----------+----------------------------------------------------------------
  q29_8 <-   |
        Fin1 |   .5816647   .0676446     8.60   0.000     .4490838    .7142456
       _cons |   3.992326   .2807674    14.22   0.000     3.442032    4.542619
  -----------+----------------------------------------------------------------
  q29_10 <-  |
        Fin1 |   .6021009    .058086    10.37   0.000     .4882545    .7159472
       _cons |   2.566349   .1252323    20.49   0.000     2.320898      2.8118
  -----------+----------------------------------------------------------------
  q30_11 <-  |
        Fin1 |   .5827095    .063635     9.16   0.000     .4579872    .7074317
       _cons |    3.15331   .1689811    18.66   0.000     2.822113    3.484507
-------------+----------------------------------------------------------------
 var(e.q29_5)|   .7629722   .0615368                      .6514122    .8936379
 var(e.q29_6)|   .6940754   .0717648                      .5667553    .8499976
 var(e.q29_7)|    .711782    .066614                      .5924956    .8550843
 var(e.q29_8)|   .6616662   .0786929                      .5240881    .8353598
var(e.q29_10)|   .6374746   .0699472                      .5141198    .7904263
var(e.q30_11)|   .6604497   .0741614                      .5299794    .8230392
    var(Fin1)|          1          .                             .           .
------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(9)   =      7.08, Prob > chi2 = 0.6289

Model Fit for CFA Models - Financial Risks.

estat mindices
(no modification indices to report, all MI values less than 3.841458820694123)
. estat gof, stats(all)
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(9) |      7.078   model vs. saturated
            p > chi2 |      0.629
         chi2_bs(15) |     73.862   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.061
              pclose |      0.898   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.054   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.045   Standardized root mean squared residual
                  CD |      0.733   Coefficient of determination
----------------------------------------------------------------------------
```

5. Contract Importance: Q30.1 - Q30.6 and Q30.13.

```
sem(Economic1 ->  q30_1 q30_2 q30_3 q30_4 q30_5 q30_6 q30_13), ///
cov(e.q30_2*e.q30_5) ///
cov(e.q30_2*e.q30_6) ///
method(adf) stand

estat mindices
estat gof, stats(all)

. sem(Economic1 ->  q30_1 q30_2 q30_3 q30_4 q30_5 q30_6 q30_13), ///
> cov(e.q30_2*e.q30_5) ///
> cov(e.q30_2*e.q30_6) ///
> method(adf) stand
note: The following observed variable name will be treated as a latent variable: Q18.  If this is not your
intention use the nocaps latent option, or identify the latent variable names in the latent() option.

Endogenous variables

Measurement:  q30_1 q30_2 q30_3 q30_4 q30_5 q30_6 q30_13

Exogenous variables

Latent:       Economic1

Fitting baseline model:

Iteration 0:   discrepancy =   2.6469136
Iteration 1:   discrepancy =   .7384569
Iteration 2:   discrepancy =   .7384569

Fitting target model:

Iteration 0:   discrepancy =   .18539664
Iteration 1:   discrepancy =   .05734924
Iteration 2:   discrepancy =   .05627611
Iteration 3:   discrepancy =   .05627174
Iteration 4:   discrepancy =   .05627174
```

```
Structural equation model                      Number of obs      =        237
Estimation method  = adf
Discrepancy        =  .05627174

(1)   [q30_1]Economic1 = 1
```

Standardized	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Measurement						
q30_1 <-						
Economic1	.7630269	.0430482	17.72	0.000	.6786541	.8473998
_cons	3.46435	.1768109	19.59	0.000	3.117807	3.810893
q30_2 <-						
Economic1	.318294	.0727807	4.37	0.000	.1756464	.4609416
_cons	2.986212	.1297704	23.01	0.000	2.731866	3.240557
q30_3 <-						
Economic1	.7296931	.0395115	18.47	0.000	.652252	.8071341
_cons	3.009246	.1677427	17.94	0.000	2.680477	3.338016
q30_4 <-						
Economic1	.1244364	.0842837	1.48	0.140	-.0407566	.2896294
_cons	4.240789	.2775831	15.28	0.000	3.696736	4.784842
q30_5 <-						
Economic1	.5447978	.0675814	8.06	0.000	.4123406	.6772549
_cons	3.269748	.1723274	18.97	0.000	2.931993	3.607504
q30_6 <-						
Economic1	.4328574	.0649276	6.67	0.000	.3056018	.5601131
_cons	3.691393	.2093495	17.63	0.000	3.281076	4.101711
q30_13 <-						
Economic1	.8391021	.0329879	25.44	0.000	.774447	.9037573
_cons	2.513475	.1094152	22.97	0.000	2.299025	2.727925
var(e.q30_1)	.4177899	.0656938			.3069827	.5685936
var(e.q30_2)	.8986889	.0463313			.8123183	.994243
var(e.q30_3)	.467548	.0576625			.3671537	.5953941
var(e.q30_4)	.9845156	.0209759			.9442501	1.026498
var(e.q30_5)	.7031954	.0736364			.572718	.8633983
var(e.q30_6)	.8126344	.0562087			.7096086	.9306183
var(e.q30_13)	.2959076	.0553605			.2050725	.4269775
var(Economic1)	1	.			.	.
cov(e.q30_2,e.q30_5)	.1908032	.0722505	2.64	0.008	.0491948	.3324116
cov(e.q30_2,e.q30_6)	.1386954	.0662417	2.09	0.036	.0088641	.2685267

```
Discr. test of model vs. saturated: chi2(12)  =    13.34, Prob > chi2 = 0.3451

. estat mindices

Modification indices
```

	MI	df	P>MI	EPC	Standard EPC
cov(e.q30_4,e.q30_13)	6.103	1	0.01	-.2253509	-.3000644

```
EPC = expected parameter change
estat gof, stats(all)
```

```
Model Fit for CFA Models - Contract Importance.
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
         chi2_ms(12) |     13.336   model vs. saturated
            p > chi2 |      0.345
         chi2_bs(21) |    175.014   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.022   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.072
              pclose |      0.777   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      0.991   Comparative fit index
                 TLI |      0.985   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.105   Standardized root mean squared residual
                  CD |      0.849   Coefficient of determination
----------------------------------------------------------------------------
```

6. Resources & Technology (R&T) Importance: Q30.7, Q30.8, Q30.10 and Q30.12.

```
sem(Economic2 ->  q30_7 q30_8 q30_10 q30_12), ///
cov(e.q30_8*e.q30_12) ///
method(adf) stand
estat mindices
estat gof, stats(all)

Structural equation model                      Number of obs      =        237
Estimation method  = adf
Discrepancy        = .00389013

(1)  [q30_7]Economic2 = 1
--------------------------------------------------------------------------------------
        Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------------+----------------------------------------------------------------
Measurement          |
  q30_7 <-           |
           Economic2 |   .4345556   .0742013     5.86   0.000     .2891237    .5799876
               _cons |   4.138652   .2512302    16.47   0.000     3.646249    4.631054
  -------------------+----------------------------------------------------------------
  q30_8 <-           |
           Economic2 |   .4507309   .0727067     6.20   0.000     .3082283    .5932334
               _cons |   2.022907   .0853082    23.71   0.000     1.855706    2.190108
  -------------------+----------------------------------------------------------------
  q30_10 <-          |
           Economic2 |   .9281193   .0919081    10.10   0.000     .7479829    1.108256
               _cons |   3.769216   .2270481    16.60   0.000      3.32421    4.214222
  -------------------+----------------------------------------------------------------
  q30_12 <-          |
           Economic2 |   .6319032   .0642697     9.83   0.000     .5059368    .7578695
               _cons |   3.182677   .1655384    19.23   0.000     2.858228    3.507126
---------------------+----------------------------------------------------------------
        var(e.q30_7) |   .8111614   .0644892                      .6941204    .9479377
        var(e.q30_8) |   .7968417   .0655423                      .6782011    .9362366
       var(e.q30_10) |   .1385945   .1706033                      .0124153     1.54716
       var(e.q30_12) |   .6006984   .0812245                      .4608501    .7829845
      var(Economic2) |          1          .                             .           .
---------------------+----------------------------------------------------------------
cov(e.q30_8,e.q30_12)|   .2924901   .0765314     3.82   0.000     .1424914    .4424888
--------------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(1)   =     0.92, Prob > chi2 = 0.3370
```

```
. estat mindices
(no modification indices to report, all MI values less than 3.841458820694123)
. estat gof, stats(all)
```

Model Fit for CFA Models - Resources & Technology (R&T) Importance.

Fit statistic	Value	Description
Discrepancy		
chi2_ms(1)	0.922	model vs. saturated
p > chi2	0.337	
chi2_bs(6)	129.343	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.000	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	0.169	
pclose	0.466	Probability RMSEA <= 0.05
Baseline comparison		
CFI	1.000	Comparative fit index
TLI	1.004	Tucker-Lewis index
Size of residuals		
SRMR	0.025	Standardized root mean squared residual
CD	0.878	Coefficient of determination

Cronbach's alpha values for Resources & Technology (R&T) Importance.

```
alpha q30_7 q30_8 q30_10 q30_12, item
. alpha q30_7 q30_8 q30_10 q30_12, item
```

Test scale = mean (unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q30_7	237	+	0.5767	0.3380	.708527	0.7366
q30_8	237	+	0.7436	0.4528	.5013469	0.6985
q30_10	237	+	0.8058	0.6396	.4360712	0.5756
q30_12	237	+	0.8121	0.6211	.4076676	0.5760
Test scale					.5134032	0.7150

7. UAE Culture: Q31.1 - Q31.5.

```
Sem (Cultural1 ->  q31_1 q31_2 q31_3 q31_4 q31_5), ///
> method(adf) stand

Endogenous variables
Measurement:  q31_1 q31_2 q31_3 q31_4 q31_5

Exogenous variables
Latent:       Cultural1

Fitting baseline model:

Iteration 0:   discrepancy =    .414595
Iteration 1:   discrepancy =  .18660289
Iteration 2:   discrepancy =  .18660289

Fitting target model:

Iteration 0:   discrepancy =  .06283245
Iteration 1:   discrepancy =  .05857542
Iteration 2:   discrepancy =  .03552605
```

```
Iteration 3:   discrepancy =  .03278839
Iteration 4:   discrepancy =   .0326361
Iteration 5:   discrepancy =  .03263583
Iteration 6:   discrepancy =  .03263583

Structural equation model                      Number of obs     =        237
Estimation method  = adf
Discrepancy        =  .03263583

(1)   [q31_1]Cultural1 = 1
------------------------------------------------------------------------------
 Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
Measurement   |
  q31_1 <-    |
    Cultural1 |   .6424145   .0790313     8.13   0.000      .487516    .7973129
        _cons |   4.385802   .2653035    16.53   0.000     3.865817    4.905788
  ------------+----------------------------------------------------------------
  q31_2 <-    |
    Cultural1 |   .5805954   .0838757     6.92   0.000     .4162021    .7449887
        _cons |    5.56572   .5471193    10.17   0.000     4.493385    6.638054
  ------------+----------------------------------------------------------------
  q31_3 <-    |
    Cultural1 |   .4597898   .0741847     6.20   0.000     .3143905    .6051891
        _cons |   5.803586   .3962004    14.65   0.000     5.027047    6.580124
  ------------+----------------------------------------------------------------
  q31_4 <-    |
    Cultural1 |   -.425912   .0766183    -5.56   0.000    -.5760811   -.2757428
        _cons |   1.724952    .053523    32.23   0.000     1.620049    1.829856
  ------------+----------------------------------------------------------------
  q31_5 <-    |
    Cultural1 |    .513474   .0892641     5.75   0.000     .3385196    .6884285
        _cons |   4.317431   .2982985    14.47   0.000     3.732777    4.902086
--------------+----------------------------------------------------------------
  var(e.q31_1)|   .5873036   .1015417                       .418499    .8241968
  var(e.q31_2)|    .662909   .0973956                       .497043    .8841252
  var(e.q31_3)|   .7885934   .0682187                      .6656077    .9343033
  var(e.q31_4)|    .818599   .0652653                       .700175    .9570527
  var(e.q31_5)|   .7363444   .0916696                      .5769159    .9398304
var(Cultural1)|          1          .                             .           .
------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(5)   =      7.73, Prob > chi2 = 0.1715
```

Model Fit for CFA Models - UAE Culture.

```
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(5) |      7.735   model vs. saturated
            p > chi2 |      0.171
         chi2_bs(10) |     44.225   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.048   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.110
              pclose |      0.446   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      0.920   Comparative fit index
                 TLI |      0.840   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.064   Standardized root mean squared residual
                  CD |      0.673   Coefficient of determination
----------------------------------------------------------------------------
```

Cronbach's alpha values for UAE Culture.
alpha q31_1 q31_2 q31_3 q31_4 q31_5, item

Test scale = mean (unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q31_1	237	+	0.6556	0.4009	.1919414	0.5358
q31_2	237	+	0.5997	0.3630	.2168109	0.5574
q31_3	237	+	0.5475	0.3322	.2382417	0.5740
q31_4	237	-	0.6678	0.3677	.1884729	0.5578
q31_5	237	+	0.6532	0.3753	.1936131	0.5501
Test scale					.205816	0.6098

8. Cultural Diversity: Q31.14 - Q31.17 and Q31.19.

* F7 Cultural2

```
factor q31_14 q31_15 q31_16 q31_17 q31_19, pcf
rotate, blanks (.3)
```

```
Factor analysis/correlation                        Number of obs    =      237
    Method: principal-component factors            Retained factors =        1
    Rotation: orthogonal varimax (Kaiser off)      Number of params =        5
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	1.88349	.	0.3767	0.3767

LR test: independent vs. saturated: chi2(10) = 93.22 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
q31_14	0.6918	0.5214
q31_15	-0.3824	0.8537
q31_16	0.6286	0.6049
q31_17	0.6542	0.5721
q31_19	0.6600	0.5644

(blanks represent abs(loading)<.3)

Cronbach's alpha values for Cultural Diversity.
alpha q31_14 q31_15 q31_16 q31_17 q31_19, item
. alpha q31_14 q31_15 q31_16 q31_17 q31_19, item

Test scale = mean (unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
q31_14	237	+	0.6382	0.4080	.219895	0.4863
q31_15	237	-	0.4510	0.1874	.3104067	0.5913
q31_16	237	+	0.6508	0.3522	.214588	0.5129
q31_17	237	+	0.6565	0.3670	.2103745	0.5031
q31_19	237	+	0.6382	0.3686	.2191441	0.5025
Test scale					.2348816	0.5772

```
Structural equation model                       Number of obs      =       237
Estimation method  = adf
Discrepancy        =  .00597452

 (1)   [q31_14]Cultural2 = 1
-------------------------------------------------------------------------------
 Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
Measurement   |
  q31_14 <-   |
    Cultural2 |   .5623808   .0789534     7.12   0.000      .407635    .7171266
        _cons |   4.555829   .3358069    13.57   0.000     3.897659    5.213998
  ------------+----------------------------------------------------------------
  q31_15 <-   |
    Cultural2 |  -.2178256   .1062792    -2.05   0.040     -.426129   -.0095223
        _cons |   3.195207   .1435884    22.25   0.000     2.913779    3.476635
  ------------+----------------------------------------------------------------
  q31_16 <-   |
    Cultural2 |   .4745795    .078061     6.08   0.000     .3215827    .6275763
        _cons |   3.115831   .1614127    19.30   0.000     2.799467    3.432194
  ------------+----------------------------------------------------------------
  q31_17 <-   |
    Cultural2 |   .5381813    .085012     6.33   0.000     .3715608    .7048019
        _cons |   3.424638   .2000943    17.12   0.000      3.03246    3.816815
  ------------+----------------------------------------------------------------
  q31_19 <-   |
    Cultural2 |   .5447782   .0698852     7.80   0.000     .4078057    .6817507
        _cons |   3.497564   .2185426    16.00   0.000     3.069228      3.9259
--------------+----------------------------------------------------------------
 var(e.q31_14)|   .6837278   .0888037                      .5300633    .8819394
 var(e.q31_15)|    .952552   .0463007                       .865993    1.047763
 var(e.q31_16)|   .7747743   .0740923                      .6423535    .9344936
 var(e.q31_17)|   .7103608   .0915038                      .5518653    .9143763
 var(e.q31_19)|   .7032167   .0761439                      .5687502    .8694744
var(Cultural2)|          1          .                             .           .
-------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(5)   =      1.42, Prob > chi2 = 0.9226

.estat mindices
(no modification indices to report, all MI values less than 3.841458820694123)
. estat gof, stats(all)

Model Fit for CFA Models - Cultural Diversity.
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
          chi2_ms(5) |      1.416   model vs. saturated
            p > chi2 |      0.923
         chi2_bs(10) |     33.492   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.000   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.030
              pclose |      0.977   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      1.000   Comparative fit index
                 TLI |      1.305   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.022   Standardized root mean squared residual
                  CD |      0.620   Coefficient of determination
----------------------------------------------------------------------------
```

9. Communication: Q31.6 - Q31.10, Q31.18, Q34.3 and Q34.9.

```
 ----------------+----------------------------------------------------------------
  q34_6 <-       |
    Communication |   .0673175   .0755451     0.89   0.373    -.0807481    .2153832
            _cons |   2.153342   .0602958    35.71   0.000     2.035165     2.27152
  ----------------+----------------------------------------------------------------
. sem (Communication ->  q31_6 q31_7 q31_8 q31_9 q31_10 q31_18 q34_3 q34_9), ///
> cov(e.q31_8*e.q34_9) ///
> cov(e.q31_9*e.q31_10) ///
> method(adf) stand

Structural equation model                       Number of obs      =       237
Estimation method  = adf
Discrepancy        = .10663495

 (1)   [q31_6]Communication = 1
------------------------------------------------------------------------------------
       Standardized |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------+---------------------------------------------------------------
Measurement         |
  q31_6 <-          |
      Communication |   .5543155    .066033     8.39   0.000     .4248933    .6837377
              _cons |      1.756   .0566025    31.02   0.000     1.645061    1.866939
  ------------------+---------------------------------------------------------------
  q31_7 <-          |
      Communication |   .5249203   .0767667     6.84   0.000     .3744604    .6753802
              _cons |   2.032344   .0762899    26.64   0.000     1.882818    2.181869
  ------------------+---------------------------------------------------------------
  q31_8 <-          |
      Communication |  -.7508035   .0482665   -15.56   0.000    -.8454041   -.6562029
              _cons |   3.288469   .1856252    17.72   0.000      2.92465    3.652287
  ------------------+---------------------------------------------------------------
  q31_9 <-          |
      Communication |  -.2246362   .0864286    -2.60   0.009    -.3940332   -.0552392
              _cons |   3.596261   .2066397    17.40   0.000     3.191254    4.001267
  ------------------+---------------------------------------------------------------
  q31_10 <-         |
      Communication |  -.5603786   .0558806   -10.03   0.000    -.6699026   -.4508547
              _cons |     4.0142   .2229227    18.01   0.000     3.577279    4.451121
  ------------------+---------------------------------------------------------------
  q31_18 <-         |
      Communication |  -.4062532    .083174    -4.88   0.000    -.5692713   -.2432351
              _cons |   4.102351   .2533637    16.19   0.000     3.605767    4.598934
  ------------------+---------------------------------------------------------------
  q34_3 <-          |
      Communication |   .2021805   .0787905     2.57   0.010     .0477539    .3566071
              _cons |   1.797631   .0489549    36.72   0.000     1.701682    1.893581
  ------------------+---------------------------------------------------------------
  q34_9 <-          |
      Communication |   .2721711   .0904725     3.01   0.003     .0948482    .4494941
              _cons |   2.451315   .0979768    25.02   0.000     2.259284    2.643346
--------------------+---------------------------------------------------------------
        var(e.q31_6)|   .6927343   .0732062                      .5631371    .8521563
        var(e.q31_7)|   .7244587   .0805928                      .5825341     .900961
        var(e.q31_8)|   .4362941   .0724773                      .3150486    .6042006
        var(e.q31_9)|   .9495386     .03883                      .8764032    1.028777
       var(e.q31_10)|   .6859758   .0626286                      .5735818    .8203935
       var(e.q31_18)|   .8349583   .0675794                      .7124767    .9784957
        var(e.q34_3)|    .959123   .0318598                      .8986683    1.023645
        var(e.q34_9)|   .9259229    .049248                      .8342593    1.027658
   var(Communication)|          1          .                             .           .
--------------------+---------------------------------------------------------------
 cov(e.q31_8,e.q34_9)|   .2352567   .0854239     2.75   0.006     .0678289    .4026845
cov(e.q31_9,e.q31_10)|    .148914   .0709227     2.10   0.036      .009908    .2879199
------------------------------------------------------------------------------------
Discr. test of model vs. saturated: chi2(18)  =    25.27, Prob > chi2 = 0.1176
```

```
estat mindices

Modification indices
---------------------------------------------------------------------
                     |                                        Standard
                     |         MI     df   P>MI        EPC         EPC
---------------------+-----------------------------------------------
cov(e.q31_9,e.q31_18)|      4.059      1   0.04   .1339323    .1456346
---------------------------------------------------------------------
EPC = expected parameter change
estat gof, stats(all)

Model Fit for CFA Models  - Communication.
----------------------------------------------------------------------------
Fit statistic        |      Value   Description
---------------------+------------------------------------------------------
Discrepancy          |
         chi2_ms(18) |     25.272   model vs. saturated
            p > chi2 |      0.118
         chi2_bs(28) |    134.380   baseline vs. saturated
            p > chi2 |      0.000
---------------------+------------------------------------------------------
Population error     |
               RMSEA |      0.041   Root mean squared error of approximation
 90% CI, lower bound |      0.000
         upper bound |      0.076
              pclose |      0.618   Probability RMSEA <= 0.05
---------------------+------------------------------------------------------
Baseline comparison  |
                 CFI |      0.932   Comparative fit index
                 TLI |      0.894   Tucker-Lewis index
---------------------+------------------------------------------------------
Size of residuals    |
                SRMR |      0.106   Standardized root mean squared residual
                  CD |      0.759   Coefficient of determination
----------------------------------------------------------------------------
Cronbach's alpha values for Communication.
alpha q31_6 q31_7 q31_8 q31_9 q31_10 q31_18 q34_3 q34_9, item

Test scale = mean (unstandardized items)
                                                            average
                             item-test     item-rest       interitem
Item         |  Obs  Sign   correlation   correlation     covariance      alpha
-------------+-----------------------------------------------------------------
q31_6        |  237    -       0.5416        0.3231        .2170152      0.6360
q31_7        |  237    -       0.5174        0.3527        .2273237      0.6285
q31_8        |  237    +       0.7325        0.5574        .1637184      0.5630
q31_9        |  237    +       0.4974        0.2845        .2284117      0.6450
q31_10       |  237    +       0.6598        0.5053        .1931546      0.5890
q31_18       |  237    +       0.5682        0.3746        .2116601      0.6214
q34_3        |  237    -       0.4049        0.1934        .2499029      0.6653
q34_9        |  237    -       0.3857        0.2157        .2533502      0.6562
-------------+-----------------------------------------------------------------
Test scale   |                                             .2180671      0.6586
-------------------------------------------------------------------------------
```

GSEM Model

GSEM Model 2 - Quality Rating for RM:

```
# q23cat2
. tab q23
                        Q23 |      Freq.     Percent        Cum.
----------------------------+-----------------------------------
          More risk-averse |        146       61.60       61.60
          More risk-taking |         33       13.92       75.53
Risk similar to competitors |         58       24.47      100.00    XXXXX
----------------------------+-----------------------------------
                      Total |        237      100.00

generate q23numeric = 0
replace q23numeric = 1 if q23=="More risk-averse"
replace q23numeric = 2 if q23=="More risk-taking"
rename q23numeric q23
recode q23 (0=0)(1=1)(2=0), gen(q23cat2)

# q26catnew
tab q26
                       Q26 |      Freq.     Percent        Cum.
---------------------------+-----------------------------------
            Chief director |         16        6.75        6.75
                  Engineer |         30       12.66       19.41
Other (s) (Please specify) |          4        1.69       21.10
           Project manager |        182       76.79       97.89    XXXXX
         Technical manager |          5        2.11      100.00
---------------------------+-----------------------------------
                     Total |        237      100.00

generate q26numeric = 0
replace q26numeric = 1 if q26=="Technical manager"
replace q26numeric = 2 if q26=="Other (s) (Please specify)"
replace q26numeric = 3 if q26=="Engineer"
replace q26numeric = 4 if q26=="Chief director"
rename q26numeric q26
recode q26 (0=0)(2=0)(1=1)(3/4=1), gen(q26catnew)

gsem ///
(practices score <- i.q19 i.q23cat2 i.q24 i.q26catnew i.q2cat2) ///
(i.q28 <- practices score  i.q18cat2 i.q24 i.q19, mlogit)

. gsem ///
> (practices score <- i.q19 i.q23cat2 i.q24 i.q26catnew i.q2cat2) ///
> (i.q28 <- practices score  i.q18cat2 i.q24 i.q19, mlogit)

Generalized structural equation model             Number of obs    =        237
Log likelihood = -290.29351
```

```
------------------------------------------------------------------------------------
                     |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------------+--------------------------------------------------------------
practicesscore <-    |
                     |
                 q19 |
                   1 |   .2160834   .0682466     3.17   0.002     .0823225    .3498443
                   2 |   .3649298   .0919178     3.97   0.000     .1847743    .5450853
                     |
           1.q23cat2 |  -.4330165   .0609966    -7.10   0.000    -.5525678   -.3134653
               1.q24 |   .5377857   .0660209     8.15   0.000     .4083871    .6671844
         1.q26catnew |   .1212579   .0686286     1.77   0.077    -.0132516    .2557675
            1.q2cat2 |   .1324958    .058456     2.27   0.023     .0179242    .2470675
               _cons |  -.0830026    .067081    -1.24   0.216     -.214479    .0484738
---------------------+--------------------------------------------------------------
0.q28                |  (base outcome)
---------------------+--------------------------------------------------------------
1.q28 <-             |
      practicesscore |   .9341684   .3463532     2.70   0.007     .2553286    1.613008
        1.q18cat2    |   .7994266   .3966615    -2.02   0.044    -1.576869   -.0219843
               1.q24 |   .2326731   .4103598     0.57   0.571    -.5716173    1.036964
                     |
                 q19 |
                   1 |   .5263257   .3989628     1.32   0.187     -.255627    1.308278
                   2 |   .4890685   .5973637     0.82   0.413    -.6817427     1.65988
                     |
               _cons |   -1.27798   .2824437    -4.52   0.000     -1.83156   -.7244009
---------------------+--------------------------------------------------------------
2.q28 <-             |
      practicesscore |   .7765672    .526392     1.48   0.140    -.2551421    1.808276
        1.q18cat2    |   1.218282   .7118473    -1.71   0.087    -2.613477    .1769134
               1.q24 |   1.330913   .6228426     2.14   0.033     .1101643    2.551662
                     |
                 q19 |
                   1 |   .2380207   .7379453     0.32   0.747    -1.208325    1.684367
                   2 |   2.159962   .6937803     3.11   0.002     .8001776    3.519746
                     |
               _cons |   -3.00248   .5525586    -5.43   0.000    -4.085475   -1.919485
---------------------+--------------------------------------------------------------
var(e.practicesscore)|   .1794604   .0164858                      .1498907    .2148634
------------------------------------------------------------------------------------
```

GSEM Model 3 - Cultural Factors and Project Success:

Success score - Project success
cultural1score - UAE culture
cultural2score - Cultural Diversity

```
# q1
# q2cat2
generate q2numeric = 0
replace q2numeric = 1 if q2=="16-20 years"
replace q2numeric = 2 if q2=="11-15 years"
replace q2numeric = 3 if q2=="6-10 years"
replace q2numeric = 4 if q2=="5 years or less"
rename q2numeric q2
recode q2(0/1=0)(2/3=1)(4=0), gen(q2cat2)
# q3

# q8cat2
generate q8num = 0
replace q8num = 1 if q8=="Diploma"
replace q8num = 2 if q8=="Graduate certificate/diploma"
replace q8num = 3 if q8=="Masters degree"
replace q8num = 4 if q8=="Other(s) (please specify)"
replace q8num = 5 if q8=="PhD"
rename q8num q8
```

```
recode q8(0/4=0)(5=1), generate(q8cat2)

# q17cat2
. tab q17
            Q17 |      Freq.     Percent        Cum.
----------------+-----------------------------------
Government owned |         31       13.08       13.08
   International |        145       61.18       74.26   XXXXX
         Private |         46       19.41       93.67
          Public |         15        6.33      100.00
----------------+-----------------------------------
           Total |        237      100.00

generate q17numeric = 0      /*International*/
replace q17numeric = 1 if q17=="Government owned"
replace q17numeric = 2 if q17=="Private"
replace q17numeric = 3 if q17=="Public"

order q17numeric, after(q17)
drop q17
rename q17numeric q17
recode q17(0/2=0) (3=1), gen(q17cat2)
# q18cat2
                             Q18 |      Freq.     Percent        Cum.
---------------------------------+-----------------------------------
                        Building |         29       12.24       12.24
                         Housing |         20        8.44       20.68
                      Industrial |         79       33.33       54.01   XXXXX
Infrastructure/heavy engineering |         94       39.66       93.67
       Other(s)  (please specify) |         15        6.33      100.00
---------------------------------+-----------------------------------
                           Total |        237      100.00

generate q18numeric = 0     /*Industrial*/
replace q18numeric = 1 if q18=="Building"
replace q18numeric = 2 if q18=="Housing"
replace q18numeric = 3 if q18=="Infrastructure/Heavy Engineering"
replace q18numeric = 4 if q18=="Other(s)  (please specify)"
rename q18numeric q18
recode q18 (0=0) (1/4=1), gen(q18cat2)

gsem (success score <- external risk score internal risk score communication score i.q17cat2 i.q18cat2) ///
(external risk score <- cultural1score cultural2score i.q8cat2 i.q2cat2 i.q18cat2) ///
(internal risk score <- cultural2score communication score external risk score i.q1 i.q2cat2) ///
(communication score <-  cultural1score cultural2score external risk score i.q2cat2 i.q3 i.q17cat2)

. gsem (success score <- external risk score internal risk score communication score i.q17cat2 i.q18cat2) ///
> (external risk score <- cultural1score cultural2score i.q8cat2 i.q2cat2 i.q18cat2) ///
> (internal risk score <- cultural2score communication score external risk score i.q1 i.q2cat2) ///
> (communication score <-  cultural1score cultural2score external risks core i.q2cat2 i.q3 i.q17cat2)

Iteration 0:   log likelihood = -584.26701
Iteration 1:   log likelihood = -584.26701

Generalized structural equation model             Number of obs    =        237
Log likelihood = -584.26701
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
successcore <-						
externalriskscore	-.2742471	.0783187	-3.50	0.000	-.4277489	-.1207453
internalriskscore	-.1746346	.0579742	-3.01	0.003	-.2882619	-.0610074
communicationscore	.2789192	.0749235	3.72	0.000	.1320719	.4257664
1.q17cat2	-.2212199	.1287215	-1.72	0.086	-.4735093	.0310696
1.q18cat2	.1174532	.0669632	1.75	0.079	-.0137923	.2486986
_cons	-.0779987	.0554038	-1.41	0.159	-.1865881	.0305907
externalriskscore <-						
cultural1score	.2441062	.0647677	3.77	0.000	.1171638	.3710486
cultural2score	.6195485	.0771708	8.03	0.000	.4682965	.7708005
1.q8cat2	.2890837	.113152	2.55	0.011	.0673099	.5108575
1.q2cat2	-.1216433	.0574624	-2.12	0.034	-.2342676	-.009019
1.q18cat2	-.1494925	.0607018	-2.46	0.014	-.2684657	-.0305192
_cons	.1311616	.0558742	2.35	0.019	.0216503	.240673
internalriskscore <-						
externalriskscore	.4824537	.07802	6.18	0.000	.3295373	.6353701
communicationscore	-.3450551	.0741442	-4.65	0.000	-.4903751	-.1997351
cultural2score	.3143375	.0994731	3.16	0.002	.1193738	.5093011
q1						
1	.1165806	.0768469	1.52	0.129	-.0340366	.2671977
2	.2724348	.0938476	2.90	0.004	.0884968	.4563727
1.q2cat2	-.3591592	.066983	-5.36	0.000	-.4904435	-.2278749
_cons	.0970806	.0507078	1.91	0.056	-.002305	.1964661
communicationscore <-						
externalriskscore	-.3918585	.0598897	-6.54	0.000	-.5092401	-.2744769
cultural1score	-.2230263	.0622814	-3.58	0.000	-.3450956	-.1009571
cultural2score	-.3143209	.0820227	-3.83	0.000	-.4750824	-.1535595
1.q2cat2	.2407559	.0544992	4.42	0.000	.1339395	.3475724
1.q3	-.0881622	.0665637	-1.32	0.185	-.2186246	.0423002
1.q17cat2	-.2425611	.1085577	-2.23	0.025	-.4553303	-.0297919
_cons	-.0351128	.0383916	-0.91	0.360	-.1103591	.0401334
var(e.successcore)	.2272791	.0208838			.1898217	.272128
var(e.externalriskscore)	.184861	.0169864			.1543941	.2213399
var(e.internalriskscore)	.2359476	.0216851			.1970538	.2825183
var(e.communicationscore)	.1641275	.0150776			.1370835	.1965067

Appendix 8: NVivo

1. Main Nodes

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Communication risks	11	24	24/02/2017 10:29 AM	AG	14/05/2017 11:40 AM	MH
Contract preparation	3	4	24/02/2017 10:23 AM	AG	14/05/2017 11:40 AM	MH
Cultural diversity	0	0	24/02/2017 10:28 AM	AG	14/05/2017 11:40 AM	MH
Current relationships	0	0	27/02/2017 5:07 PM	AG	14/05/2017 11:40 AM	MH
Current risk management practices	0	0	24/02/2017 10:18 AM	AG	14/05/2017 11:40 AM	MH
Decision making and planning processes	0	0	5/03/2017 5:22 PM	AG	14/05/2017 11:41 AM	MH
External risks	0	0	24/02/2017 10:20 AM	AG	14/05/2017 11:41 AM	MH
Financial risks	1	8	24/02/2017 10:21 AM	AG	14/05/2017 11:41 AM	MH
Financing of construction projects	0	0	27/02/2017 5:19 PM	AG	14/05/2017 11:41 AM	MH
Improvements for Risk Management Practices	0	0	27/02/2017 2:53 PM	AG	14/05/2017 11:41 AM	MH
Internal risks	0	0	24/02/2017 10:20 AM	AG	14/05/2017 11:41 AM	MH
Learning Process of what happened in project	0	0	9/03/2017 8:37 AM	AG	14/05/2017 11:41 AM	MH
Other risks	0	0	27/02/2017 5:57 PM	AG	14/05/2017 11:41 AM	MH
Resources and Technology	0	0	24/02/2017 10:24 AM	AG	14/05/2017 11:41 AM	MH
Risk allocation practices	0	0	27/02/2017 2:28 PM	AG	14/05/2017 11:41 AM	MH
Risk allocation practices - best performance suggestions	0	0	2/03/2017 12:39 PM	AG	14/05/2017 11:41 AM	MH
Risk management attitudes	1	2	28/02/2017 3:31 PM	AG	14/05/2017 11:41 AM	MH
Risk management performance in UAE	0	0	28/02/2017 12:03 PM	AG	14/05/2017 11:42 AM	MH
Selecting a contractor	0	0	27/02/2017 4:32 PM	AG	14/05/2017 11:42 AM	MH
Significance of economic and cultural factors	0	0	8/03/2017 2:23 PM	AG	14/05/2017 11:42 AM	MH
Size of projects interviewee involved in	0	0	5/03/2017 5:11 PM	AG	14/05/2017 11:42 AM	MH
Strategies to improve economic and cultural factors	1	4	27/02/2017 4:08 PM	AG	14/05/2017 11:42 AM	MH
UAE culture	9	27	24/02/2017 10:26 AM	AG	14/05/2017 11:42 AM	MH
Work volume	1	1	25/02/2017 9:43 AM	AG	14/05/2017 11:42 AM	MH

1.2 Sub Nodes

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Communication risks	11	24	24/02/2017 10:29 AM	AG	14/05/2017 11:40 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Culturally specific communication risks	0	0	9/03/2017 11:12 AM	AG	9/03/2017 11:12 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Quiet approach to handling problems	1	1	9/03/2017 11:12 AM	AG	9/03/2017 11:13 AM	AG
Contract preparation	3	4	24/02/2017 10:23 AM	AG	14/05/2017 11:40 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Impact	0	0	5/03/2017 8:00 PM	AG	5/03/2017 8:00 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cost overruns	1	1	9/03/2017 10:42 AM	AG	9/03/2017 10:43 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Incomplete contract document	1	1	9/03/2017 1:56 PM	AG	9/03/2017 1:56 PM	AG
Unclear objectives	2	2	7/03/2017 4:37 PM	AG	9/03/2017 7:33 PM	AG
Unclear roles and responsibilities	1	1	9/03/2017 10:41 AM	AG	9/03/2017 10:42 AM	AG
Cultural diversity	0	0	24/02/2017 10:28 AM	AG	14/05/2017 11:40 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Custom differences	3	3	1/03/2017 5:12 PM	AG	10/03/2017 12:42 PM	AG
Decision making processes	0	0	5/03/2017 6:14 PM	AG	9/03/2017 12:09 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Different decision making processes	4	4	5/03/2017 5:41 PM	AG	8/03/2017 4:54 PM	AG
Poor experience in decision making processes	2	2	5/03/2017 6:14 PM	AG	9/03/2017 7:53 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Different dispute resolution	1	1	5/03/2017 5:41 PM	AG	9/03/2017 12:09 PM	AG
Different language	9	13	1/03/2017 5:23 PM	AG	9/03/2017 12:09 PM	AG
Different ways of thinking	1	1	5/03/2017 8:09 PM	AG	9/03/2017 12:09 PM	AG
Emiritisation process	2	2	8/03/2017 8:07 PM	AG	9/03/2017 12:09 PM	AG
Employment of women - success	1	1	8/03/2017 8:05 PM	AG	9/03/2017 12:09 PM	AG
High turnover of employment	1	2	8/03/2017 8:10 PM	AG	10/03/2017 12:37 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Lack of depth in technical knowledge	1	1	8/03/2017 8:11 PM	AG	9/03/2017 9:10 PM	AG

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Lots of expatriate workers	4	5	5/03/2017 8:34 PM	AG	9/03/2017 12:09 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Competition with other companies	1	1	5/03/2017 8:35 PM	AG	5/03/2017 8:35 PM	AG
Limited pool of talent	1	1	8/03/2017 7:48 PM	AG	8/03/2017 7:49 PM	AG
Current relationships	0	0	27/02/2017 5:07 PM	AG	14/05/2017 11:40 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Blame culture	1	2	9/03/2017 8:07 AM	AG	9/03/2017 7:41 PM	AG
Consultants	0	0	9/03/2017 8:19 AM	AG	9/03/2017 8:19 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Face financial risks	1	1	9/03/2017 8:19 AM	AG	9/03/2017 8:21 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Delay	1	1	9/03/2017 8:19 AM	AG	9/03/2017 8:20 AM	AG
Design changes	1	1	9/03/2017 8:20 AM	AG	9/03/2017 8:20 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Contractors	0	0	9/03/2017 7:45 AM	AG	9/03/2017 7:46 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Allocated all risks associated with work	3	3	9/03/2017 8:10 AM	AG	9/03/2017 8:33 AM	AG
Face financial risks	2	2	9/03/2017 7:46 AM	AG	9/03/2017 8:05 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Contract clause - offset risk of non-payment	1	1	9/03/2017 8:10 AM	AG	9/03/2017 8:12 AM	AG
Delay of financial resources	1	1	9/03/2017 7:58 AM	AG	9/03/2017 8:19 AM	AG
Late payment by client	2	2	9/03/2017 7:49 AM	AG	9/03/2017 7:58 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Limited financial backing	1	1	9/03/2017 8:04 AM	AG	9/03/2017 8:04 AM	AG
Suggestions	0	0	9/03/2017 7:44 AM	AG	9/03/2017 7:44 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Close relationship with all key stakeholders	2	2	9/03/2017 7:44 AM	AG	9/03/2017 8:32 AM	AG
Professional at all times	1	1	9/03/2017 8:27 AM	AG	9/03/2017 8:27 AM	AG
Team work - consider different perspectives	2	2	9/03/2017 8:28 AM	AG	9/03/2017 8:31 AM	AG

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Conflicting	4	4	9/03/2017 7:43 AM	AG	9/03/2017 8:24 AM	AG
Good	0	0	9/03/2017 7:43 AM	AG	9/03/2017 7:43 AM	AG
Negative	3	3	9/03/2017 8:09 AM	AG	9/03/2017 8:25 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
With consultant	0	0	9/03/2017 7:42 AM	AG	9/03/2017 7:42 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Conflicting	2	2	9/03/2017 7:43 AM	AG	9/03/2017 8:18 AM	AG
Good	1	1	9/03/2017 7:43 AM	AG	9/03/2017 8:05 AM	AG
Negative	2	2	9/03/2017 7:56 AM	AG	9/03/2017 8:09 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
With contractor	0	0	9/03/2017 7:42 AM	AG	9/03/2017 7:42 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Conflicting	3	3	9/03/2017 7:43 AM	AG	9/03/2017 8:24 AM	AG
Good	1	1	9/03/2017 7:42 AM	AG	9/03/2017 8:05 AM	AG
Negative	2	2	9/03/2017 7:57 AM	AG	9/03/2017 8:25 AM	AG
Current risk management practices	0	0	24/02/2017 10:18 AM	AG	14/05/2017 11:40 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cultural risk strategies	3	3	8/03/2017 7:53 PM	AG	9/03/2017 10:56 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Find areas in project that require experts	1	1	8/03/2017 7:53 PM	AG	8/03/2017 7:54 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Prepare relevant budget and resource allocation	0	0	8/03/2017 7:54 PM	AG	9/03/2017 6:05 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
No strategies in place	1	1	8/03/2017 8:24 PM	AG	8/03/2017 8:24 PM	AG
Safety communicated in different languages	1	1	8/03/2017 8:06 PM	AG	8/03/2017 8:06 PM	AG

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Economic risk strategies	0	0	9/03/2017 6:04 AM	AG	10/03/2017 9:37 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Budget allowances	2	2	9/03/2017 6:04 AM	AG	9/03/2017 6:06 AM	AG
Transfer all risks to contractors	1	1	9/03/2017 6:07 AM	AG	9/03/2017 6:07 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Engage a consultant for expert assessment, judgment	2	2	7/03/2017 4:41 PM	AG	7/03/2017 4:47 PM	AG
Integrate risk management into program management processes	2	2	7/03/2017 4:48 PM	AG	10/03/2017 9:32 AM	AG
International standards	2	3	7/03/2017 4:41 PM	AG	10/03/2017 9:37 AM	AG
None used	2	2	7/03/2017 11:44 AM	AG	10/03/2017 9:26 AM	AG
Quality control and assurance	2	4	28/02/2017 11:03 AM	AG	10/03/2017 9:23 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Quality administered	1	1	28/02/2017 11:05 AM	AG	28/02/2017 11:05 AM	AG
Second opinion provided	1	1	28/02/2017 11:05 AM	AG	28/02/2017 11:05 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk management activities and training	2	2	6/03/2017 9:11 AM	AG	6/03/2017 9:26 AM	AG
Risk management and mitigation	7	7	6/03/2017 10:43 AM	AG	7/03/2017 4:48 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Communication plan	1	1	6/03/2017 4:45 PM	AG	6/03/2017 4:45 PM	AG
Evaluation and analysis	6	10	7/03/2017 9:53 AM	AG	10/03/2017 9:34 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Other analysis techniques	5	18	7/03/2017 8:13 AM	AG	7/03/2017 8:26 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Brainstorming	1	1	6/03/2017 9:44 AM	AG	6/03/2017 9:44 AM	AG
Cause and effect diagrams	2	2	6/03/2017 9:24 AM	AG	6/03/2017 9:43 AM	AG
Checklist analysis	2	2	6/03/2017 9:49 AM	AG	7/03/2017 6:51 AM	AG
Delphi technique	2	2	6/03/2017 9:15 AM	AG	6/03/2017 9:40 AM	AG
Document reviews	1	1	6/03/2017 5:17 PM	AG	6/03/2017 5:17 PM	AG
Influence diagrams	1	1	6/03/2017 9:13 AM	AG	6/03/2017 9:13 AM	AG
Information gathering	1	1	6/03/2017 9:52 AM	AG	6/03/2017 9:52 AM	AG
Interviewing	1	1	6/03/2017 9:45 AM	AG	6/03/2017 9:45 AM	AG
Root cause analysis	1	1	6/03/2017 9:44 AM	AG	6/03/2017 9:44 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Simulations	2	2	6/03/2017 9:13 AM	AG	6/03/2017 9:40 AM	AG
SWOT analysis	3	4	6/03/2017 9:25 AM	AG	6/03/2017 5:07 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Qualitative and quantitative analysis	10	40	6/03/2017 5:27 PM	AG	7/03/2017 8:26 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Qualitative	7	21	7/03/2017 7:41 AM	AG	7/03/2017 11:25 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Assumptions analysis	4	5	6/03/2017 9:14 AM	AG	7/03/2017 6:51 AM	AG
Engineering judgement	1	1	6/03/2017 9:14 AM	AG	6/03/2017 9:15 AM	AG
Experience	2	2	7/03/2017 7:54 AM	AG	7/03/2017 8:04 AM	AG
Expert judgement	1	1	6/03/2017 9:51 AM	AG	6/03/2017 9:51 AM	AG
Previous project data analysis	1	1	7/03/2017 8:05 AM	AG	7/03/2017 8:06 AM	AG
Risk categorisation	1	1	7/03/2017 7:47 AM	AG	7/03/2017 7:47 AM	AG
Risk matrix	4	5	6/03/2017 9:10 AM	AG	7/03/2017 7:44 AM	AG
System flow charts	3	4	6/03/2017 9:24 AM	AG	7/03/2017 6:54 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Quantitative	6	13	7/03/2017 7:41 AM	AG	7/03/2017 11:25 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Calculate probability and impact	1	1	7/03/2017 7:08 AM	AG	7/03/2017 8:04 AM	AG
Decision tree analysis	4	4	6/03/2017 9:08 AM	AG	7/03/2017 7:43 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk response strategies	1	1	6/03/2017 9:09 AM	AG	6/03/2017 9:10 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Expected Monetary Value (EMV)	2	2	6/03/2017 9:33 AM	AG	7/03/2017 8:02 AM	AG
Monte Carlo analysis	3	3	6/03/2017 9:34 AM	AG	7/03/2017 11:25 AM	AG
Probability diagrams	1	1	7/03/2017 8:12 AM	AG	7/03/2017 8:13 AM	AG
Probability distributions	1	1	7/03/2017 8:03 AM	AG	7/03/2017 8:03 AM	AG
Tornado diagrams	1	1	6/03/2017 9:34 AM	AG	6/03/2017 9:35 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Monitoring and identification	9	19	7/03/2017 9:53 AM	AG	10/03/2017 9:33 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Assign risk response owners	3	3	6/03/2017 9:12 AM	AG	7/03/2017 6:49 AM	AG
Risk mitigation	4	5	7/03/2017 9:54 AM	AG	7/03/2017 11:28 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Active regular management of retained risks	3	4	7/03/2017 11:17 AM	AG	7/03/2017 2:11 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Quality control and inspections	1	1	7/03/2017 11:20 AM	AG	7/03/2017 11:21 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Insurance	1	1	7/03/2017 11:17 AM	AG	7/03/2017 11:17 AM	AG
Probability of occurrence	1	1	7/03/2017 10:02 AM	AG	7/03/2017 10:06 AM	AG
Retain risk	1	1	7/03/2017 11:28 AM	AG	7/03/2017 11:29 AM	AG
Risk sharing	3	4	7/03/2017 9:54 AM	AG	7/03/2017 11:28 AM	AG
Severity	1	1	7/03/2017 10:03 AM	AG	7/03/2017 10:06 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk planning	3	3	7/03/2017 9:54 AM	AG	7/03/2017 10:42 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Use of work breakdown structures (WBS)	3	5	25/02/2017 10:13 AM	AG	10/03/2017 9:16 AM	AG
Decision making and planning processes	0	0	5/03/2017 5:22 PM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
None or can't answer	3	3	8/03/2017 6:58 AM	AG	8/03/2017 1:57 PM	AG
Regular communication with stakeholder	2	2	8/03/2017 1:53 PM	AG	8/03/2017 2:00 PM	AG
Risk management process is a part of decision making	7	7	8/03/2017 7:00 AM	AG	10/03/2017 7:40 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Budget control	1	1	8/03/2017 1:55 PM	AG	8/03/2017 1:55 PM	AG
Contingency funds are a part of planning	2	2	8/03/2017 6:59 AM	AG	10/03/2017 7:47 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Who makes decisions	0	0	8/03/2017 2:03 PM	AG	8/03/2017 2:03 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Client	1	1	8/03/2017 2:08 PM	AG	8/03/2017 2:08 PM	AG
Key project stakeholders	2	2	8/03/2017 2:05 PM	AG	8/03/2017 2:12 PM	AG
Project team	2	3	8/03/2017 2:03 PM	AG	8/03/2017 2:21 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
External risks	0	0	24/02/2017 10:20 AM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Corruption	3	5	27/02/2017 3:34 PM	AG	9/03/2017 7:49 PM	AG
Cultural differences	6	6	27/02/2017 3:35 PM	AG	9/03/2017 9:21 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Different education	5	7	1/03/2017 5:25 PM	AG	9/03/2017 7:59 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Experience	2	2	8/03/2017 2:55 PM	AG	9/03/2017 7:20 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Lack of experience on similar projects	1	1	9/03/2017 7:17 PM	AG	9/03/2017 7:17 PM	AG
Lack of qualified experts and knowledge	5	8	9/03/2017 1:20 PM	AG	10/03/2017 10:14 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Experienced workers move on to other projects	2	3	9/03/2017 8:46 AM	AG	9/03/2017 2:03 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Knowledge	4	6	8/03/2017 2:55 PM	AG	10/03/2017 8:37 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Different values	4	4	5/03/2017 8:04 PM	AG	9/03/2017 7:59 PM	AG
Work culture	4	4	8/03/2017 2:50 PM	AG	9/03/2017 7:59 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Global financial crisis	1	1	5/03/2017 8:21 PM	AG	5/03/2017 8:22 PM	AG
Impacts	0	0	5/03/2017 7:32 PM	AG	5/03/2017 7:32 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Change not communicated quickly enough	1	1	8/03/2017 3:55 PM	AG	8/03/2017 3:55 PM	AG
Change to budget and budget parameters	1	1	8/03/2017 3:50 PM	AG	8/03/2017 3:54 PM	AG
Non-payment	1	1	8/03/2017 3:04 PM	AG	8/03/2017 3:06 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Contractors not going the extra mile	1	1	8/03/2017 3:05 PM	AG	8/03/2017 3:05 PM	AG
Unfinished or sloppy work	1	1	8/03/2017 3:06 PM	AG	8/03/2017 3:06 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Slowing project management decisions	1	1	5/03/2017 7:32 PM	AG	5/03/2017 7:32 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Market demands	6	11	27/02/2017 3:35 PM	AG	9/03/2017 8:07 PM	AG
Oil price	4	4	5/03/2017 6:37 PM	AG	8/03/2017 2:46 PM	AG
Political and social stability	3	4	5/03/2017 8:25 PM	AG	9/03/2017 9:21 PM	AG
Short notice economic changes	1	1	27/02/2017 3:49 PM	AG	27/02/2017 3:50 PM	AG
Suggestions to control	0	0	5/03/2017 7:15 PM	AG	5/03/2017 7:16 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Careful planning	2	2	27/02/2017 4:22 PM	AG	5/03/2017 8:24 PM	AG
Watch world economic drivers	1	1	27/02/2017 4:22 PM	AG	5/03/2017 7:15 PM	AG
Financial risks	1	8	24/02/2017 10:21 AM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Budget issues	7	13	28/02/2017 11:58 AM	AG	10/03/2017 10:01 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Budget cuts	1	2	24/02/2017 2:00 PM	AG	28/02/2017 10:20 AM	AG
Budget funding delays	1	1	5/03/2017 7:11 PM	AG	5/03/2017 7:11 PM	AG
Budget re-planning	2	2	25/02/2017 10:00 AM	AG	9/03/2017 7:34 PM	AG
Cost overrun	6	8	27/02/2017 3:52 PM	AG	9/03/2017 8:04 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Delayed payment to staff	1	1	9/03/2017 7:43 PM	AG	9/03/2017 7:45 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
No desire to do better work	1	1	9/03/2017 7:44 PM	AG	9/03/2017 7:44 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Financial difficulties - client, owner, contractor	2	2	5/03/2017 5:38 PM	AG	9/03/2017 1:49 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Late payments by client	4	4	9/03/2017 1:48 PM	AG	9/03/2017 7:52 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Foreign exchange	9	16	27/02/2017 3:36 PM	AG	9/03/2017 8:04 PM	AG
Impacts	0	0	5/03/2017 7:29 PM	AG	5/03/2017 7:29 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Acquiring resources issues	1	1	5/03/2017 7:29 PM	AG	5/03/2017 7:29 PM	AG
Budget funding delays	1	1	5/03/2017 7:30 PM	AG	5/03/2017 7:31 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cost of construction influenced	1	1	8/03/2017 2:47 PM	AG	8/03/2017 2:48 PM	AG
Project unprofitable	2	2	5/03/2017 7:29 PM	AG	6/03/2017 4:47 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Increased (or changed) prices of materials and rates	5	6	5/03/2017 5:34 PM	AG	9/03/2017 8:05 PM	AG
Inflation	9	12	27/02/2017 3:36 PM	AG	9/03/2017 8:00 PM	AG
Interest rates	5	6	27/02/2017 3:36 PM	AG	9/03/2017 8:00 PM	AG
Lack of financial resources	6	7	5/03/2017 5:35 PM	AG	9/03/2017 9:22 PM	AG
Loss of profit	1	1	9/03/2017 1:14 PM	AG	9/03/2017 1:14 PM	AG
Financing of construction projects	0	0	27/02/2017 5:19 PM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
DIRE	1	1	9/03/2017 9:33 PM	AG	9/03/2017 9:33 PM	AG
Government approvalfinancing	5	6	27/02/2017 5:19 PM	AG	9/03/2017 9:32 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Major changes in finances	1	1	27/02/2017 5:23 PM	AG	27/02/2017 5:23 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Islamic finance structures	1	1	9/03/2017 9:31 PM	AG	9/03/2017 9:31 PM	AG
Large public private partnerships	1	1	9/03/2017 9:30 PM	AG	9/03/2017 9:31 PM	AG
More regional, lower level of authority	1	1	27/02/2017 5:21 PM	AG	27/02/2017 5:23 PM	AG
Not able to answer	3	3	9/03/2017 9:29 PM	AG	9/03/2017 9:30 PM	AG
Improvements for Risk Management Practices	0	0	27/02/2017 2:53 PM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Communication risk suggestions for improvement	8	14	9/03/2017 10:50 AM	AG	9/03/2017 11:03 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Effective communication of risk actions and updates	1	1	9/03/2017 11:05 AM	AG	9/03/2017 11:06 AM	AG
Good communication between all stakeholders and workers	7	12	9/03/2017 11:07 AM	AG	9/03/2017 11:59 AM	AG
Immediate communication of any changes	1	1	9/03/2017 10:50 AM	AG	9/03/2017 10:59 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Contract related suggestions	9	26	7/03/2017 11:55 AM	AG	9/03/2017 7:01 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Accurate budget estimate	1	1	7/03/2017 12:00 PM	AG	8/03/2017 3:35 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Clear contractual terms and conditions	6	8	5/03/2017 7:43 PM	AG	9/03/2017 9:53 AM	AG
Plan for controlling cost and schedule	7	8	5/03/2017 7:46 PM	AG	8/03/2017 3:35 PM	AG
Responsibility and role allocation	4	7	7/03/2017 3:04 PM	AG	9/03/2017 9:40 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cultural AND economic risk - strategies	0	0	8/03/2017 3:33 PM	AG	9/03/2017 6:54 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Clearly defined risk management process and plan	4	4	8/03/2017 3:58 PM	AG	9/03/2017 6:15 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
System for risk mitigation strategies communication	2	2	8/03/2017 4:44 PM	AG	8/03/2017 5:00 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Clearly defined roles and responsibilities	2	2	8/03/2017 4:09 PM	AG	9/03/2017 9:47 AM	AG
Contractual improvements	2	10	8/03/2017 4:17 PM	AG	9/03/2017 6:52 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Bill pricing during bidding phase	2	2	8/03/2017 4:20 PM	AG	9/03/2017 5:48 AM	AG
Clear terms and conditions	2	2	8/03/2017 4:20 PM	AG	9/03/2017 5:49 AM	AG
Define authority and responsibility	2	3	8/03/2017 4:25 PM	AG	9/03/2017 5:49 AM	AG
Employ consultant - market demand forecasts	1	1	8/03/2017 4:24 PM	AG	8/03/2017 4:24 PM	AG
Plan for control of schedule and cost	2	2	8/03/2017 4:21 PM	AG	9/03/2017 5:48 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cultural	0	0	8/03/2017 3:40 PM	AG	10/03/2017 1:45 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Good communication	3	3	8/03/2017 2:34 PM	AG	9/03/2017 12:11 PM	AG
Good relationships	2	2	8/03/2017 2:33 PM	AG	9/03/2017 12:11 PM	AG
Language barrier suggestions for improvement	0	0	9/03/2017 11:35 AM	AG	9/03/2017 12:11 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Multi-lingual supervisor	2	2	1/03/2017 5:28 PM	AG	9/03/2017 10:08 AM	AG
Visual methods for communicating	1	1	9/03/2017 11:36 AM	AG	9/03/2017 11:36 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Religion considerations and working hours	2	3	8/03/2017 3:01 PM	AG	10/03/2017 7:09 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Hire of foreign labour to compensate for low productivity months	1	1	10/03/2017 7:02 AM	AG	10/03/2017 7:02 AM	AG
Prayer timing	2	2	10/03/2017 7:07 AM	AG	10/03/2017 7:09 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Restricted diet considerations on site from foreign companies	1	1	10/03/2017 7:04 AM	AG	10/03/2017 7:05 AM	AG
Team work and sharing culture	2	2	8/03/2017 3:07 PM	AG	9/03/2017 12:11 PM	AG
Trust in project management team	1	1	8/03/2017 2:35 PM	AG	9/03/2017 12:11 PM	AG
Understanding and experience in cultures (and customs)	4	5	5/03/2017 7:52 PM	AG	9/03/2017 12:11 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Early delivery of information	1	1	8/03/2017 2:34 PM	AG	8/03/2017 2:38 PM	AG
Economic	0	0	8/03/2017 3:41 PM	AG	8/03/2017 3:41 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Clearly defined risk management process and plan	1	1	8/03/2017 4:11 PM	AG	8/03/2017 4:11 PM	AG
Forecast market demands using reputable consultants	1	1	9/03/2017 5:40 AM	AG	9/03/2017 5:41 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Knowledge and experience within team	3	3	8/03/2017 2:35 PM	AG	9/03/2017 5:50 AM	AG
No strategy	1	1	8/03/2017 7:45 PM	AG	8/03/2017 7:45 PM	AG
Transfer all risk to contractors	0	0	8/03/2017 7:40 PM	AG	9/03/2017 6:07 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Emphasis on safety standards	1	1	7/03/2017 4:32 PM	AG	8/03/2017 3:35 PM	AG
Experience and expertise are needed	11	27	7/03/2017 11:03 AM	AG	9/03/2017 10:40 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Need for training and education	9	13	7/03/2017 2:27 PM	AG	9/03/2017 7:50 PM	AG
Use of previous projects	3	3	7/03/2017 2:40 PM	AG	9/03/2017 9:57 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Financial accountability and management	4	8	7/03/2017 3:49 PM	AG	9/03/2017 11:21 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Country economic	1	1	7/03/2017 4:24 PM	AG	7/03/2017 4:24 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Continuous monitoring and review of project	2	4	8/03/2017 3:35 PM	AG	9/03/2017 6:26 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Improve record-keeping practices	2	5	7/03/2017 7:58 AM	AG	9/03/2017 9:24 AM	AG
Integrate risk management and project management	3	4	6/03/2017 10:41 AM	AG	8/03/2017 3:35 PM	AG
Need to implement risk management process	7	12	6/03/2017 10:47 AM	AG	9/03/2017 11:32 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Drivers for implementation	2	4	7/03/2017 3:35 PM	AG	9/03/2017 10:10 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Boards understanding and enforcement	1	1	7/03/2017 3:35 PM	AG	7/03/2017 3:36 PM	AG
Internal audits	1	1	7/03/2017 3:35 PM	AG	7/03/2017 3:36 PM	AG
Senior management support	2	2	7/03/2017 3:35 PM	AG	7/03/2017 4:19 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Environmental factors (heat)	2	2	7/03/2017 4:08 PM	AG	9/03/2017 10:10 AM	AG
Monitoring and identification	9	13	7/03/2017 11:38 AM	AG	9/03/2017 9:48 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
On-site risk tracking needed	1	1	9/03/2017 9:58 AM	AG	9/03/2017 9:59 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk evaluation and analysis	4	4	7/03/2017 7:26 AM	AG	8/03/2017 3:56 PM	AG
Risk response	2	2	6/03/2017 10:47 AM	AG	8/03/2017 3:56 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Assign best suited risk response officers	2	2	7/03/2017 11:58 AM	AG	10/03/2017 1:33 PM	AG
Create working groups	1	1	7/03/2017 4:07 PM	AG	7/03/2017 4:07 PM	AG
Risk mitigation	4	4	7/03/2017 11:42 AM	AG	7/03/2017 4:06 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Active regular management of retained risks	1	1	7/03/2017 2:04 PM	AG	7/03/2017 2:05 PM	AG
Probability of occurrence	1	2	7/03/2017 1:53 PM	AG	7/03/2017 2:00 PM	AG
Risk sharing	2	3	7/03/2017 11:42 AM	AG	8/03/2017 2:58 PM	AG
Severity	1	1	7/03/2017 1:52 PM	AG	7/03/2017 1:53 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk planning	2	2	7/03/2017 11:42 AM	AG	8/03/2017 3:56 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not taking on too many projects	1	1	7/03/2017 2:43 PM	AG	8/03/2017 3:35 PM	AG
Regular monitoring of project and risk	5	5	7/03/2017 11:00 AM	AG	8/03/2017 3:35 PM	AG
Suggested techniques to use	5	10	7/03/2017 7:21 AM	AG	8/03/2017 3:35 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Checklist analysis method	1	1	7/03/2017 7:23 AM	AG	8/03/2017 3:35 PM	AG
Completion of WBS	3	3	6/03/2017 5:32 PM	AG	8/03/2017 3:35 PM	AG
Decision Trees	1	1	27/02/2017 2:57 PM	AG	8/03/2017 3:35 PM	AG
Qualitative or quantitative method	3	3	7/03/2017 7:26 AM	AG	8/03/2017 3:35 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Qualitative	0	0	7/03/2017 7:37 AM	AG	7/03/2017 7:53 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Interview project managers	1	1	7/03/2017 7:38 AM	AG	7/03/2017 7:38 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Quantitative	0	0	7/03/2017 7:37 AM	AG	7/03/2017 7:57 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Count number of risks	1	1	7/03/2017 7:37 AM	AG	7/03/2017 7:38 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Length of time project is delayed by them	1	1	7/03/2017 7:38 AM	AG	7/03/2017 7:38 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Expected monetary value (EMV)	1	1	7/03/2017 7:57 AM	AG	7/03/2017 7:58 AM	AG
Monte Carlo method	1	1	6/03/2017 10:40 AM	AG	7/03/2017 7:23 AM	AG
Probability distribution	1	1	7/03/2017 7:57 AM	AG	7/03/2017 7:57 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk matrix	1	1	7/03/2017 2:32 PM	AG	8/03/2017 3:35 PM	AG
SWOT analysis	1	1	7/03/2017 7:24 AM	AG	8/03/2017 3:35 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Supply chain management (resources)	4	5	7/03/2017 2:20 PM	AG	9/03/2017 9:52 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Internal risks	0	0	24/02/2017 10:20 AM	AG	14/05/2017 11:41 AM	MH
Delays in mobilising suitable workforce	2	2	5/03/2017 5:44 PM	AG	9/03/2017 9:24 PM	AG
HR	4	4	28/02/2017 11:07 AM	AG	9/03/2017 8:08 PM	AG
Follow up missed risks	1	1	28/02/2017 11:08 AM	AG	28/02/2017 11:08 AM	AG
Impacts of internal risks	0	0	5/03/2017 5:27 PM	AG	5/03/2017 5:28 PM	AG
Additional cost	1	1	5/03/2017 7:36 PM	AG	5/03/2017 7:37 PM	AG
Delays	1	5	5/03/2017 5:28 PM	AG	5/03/2017 7:37 PM	AG
Low productivity	1	1	5/03/2017 7:34 PM	AG	5/03/2017 7:35 PM	AG
Rework requirements	1	2	5/03/2017 7:35 PM	AG	5/03/2017 7:37 PM	AG
Inadequate project management	1	1	5/03/2017 5:26 PM	AG	5/03/2017 5:27 PM	AG
Inadequate quality control	4	4	5/03/2017 5:43 PM	AG	10/03/2017 9:55 AM	AG
Interaction with other projects nearby	1	1	5/03/2017 5:46 PM	AG	5/03/2017 5:46 PM	AG
Limited access	1	1	5/03/2017 5:47 PM	AG	5/03/2017 5:47 PM	AG
Limited accommodation for workforce	1	1	5/03/2017 5:47 PM	AG	5/03/2017 5:47 PM	AG
Limited laydown areas	1	1	5/03/2017 5:47 PM	AG	5/03/2017 5:48 PM	AG
Traffic congestion	1	1	5/03/2017 5:46 PM	AG	5/03/2017 5:48 PM	AG
Labour supply	4	4	5/03/2017 5:38 PM	AG	9/03/2017 1:42 PM	AG
Lack of compliance with safety and risk management processes	1	1	9/03/2017 1:13 PM	AG	10/03/2017 9:56 AM	AG
Site safety - poor supervision and practices	6	8	28/02/2017 11:17 AM	AG	9/03/2017 8:34 PM	AG
Could stop project	1	1	28/02/2017 11:19 AM	AG	28/02/2017 11:19 AM	AG
Lack of available utilities on site	1	1	5/03/2017 5:50 PM	AG	5/03/2017 5:50 PM	AG
No insurance for equipment and employees	1	1	5/03/2017 5:50 PM	AG	5/03/2017 5:50 PM	AG
Regarded as unnecessary cost	1	1	28/02/2017 11:18 AM	AG	28/02/2017 11:18 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Learning Process of what happened in project	0	0	9/03/2017 8:37 AM	AG	14/05/2017 11:41 AM	MH
Different projects - different risks involved in most cases	1	1	9/03/2017 9:15 AM	AG	9/03/2017 9:16 AM	AG
No set learning process used	4	4	9/03/2017 9:13 AM	AG	9/03/2017 9:32 AM	AG
Lack of care as long as money is made	1	1	9/03/2017 9:20 AM	AG	9/03/2017 9:22 AM	AG
Project review or learning process used	7	7	9/03/2017 9:12 AM	AG	10/03/2017 7:21 AM	AG
Final estimate of loss due to risk documented	1	1	9/03/2017 9:28 AM	AG	9/03/2017 9:29 AM	AG
Financial estimates and review	3	3	9/03/2017 9:18 AM	AG	9/03/2017 9:31 AM	AG
Management of risk	2	2	9/03/2017 9:17 AM	AG	9/03/2017 9:29 AM	AG
Strengths and weaknesses for different processes reviewed	1	1	9/03/2017 9:31 AM	AG	9/03/2017 9:32 AM	AG
Successes and failures (risks) that were identified during project	5	5	9/03/2017 9:17 AM	AG	9/03/2017 10:02 AM	AG
Suggestions for future projects	5	5	9/03/2017 9:18 AM	AG	9/03/2017 10:01 AM	AG
Suggestions	0	0	9/03/2017 9:34 AM	AG	9/03/2017 9:34 AM	AG
Learn lessons to happen throughout project life	1	1	9/03/2017 9:34 AM	AG	9/03/2017 9:34 AM	AG
All stakeholders to be involved	1	1	9/03/2017 9:35 AM	AG	9/03/2017 9:36 AM	AG
Learnings to be transmitted to Principals	1	1	9/03/2017 9:35 AM	AG	9/03/2017 9:35 AM	AG
Successes and failures	1	1	9/03/2017 9:34 AM	AG	9/03/2017 9:35 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Other risks	0	0	27/02/2017 5:57 PM	AG	14/05/2017 11:41 AM	MH
Complexity of project	1	1	9/03/2017 9:19 PM	AG	9/03/2017 9:19 PM	AG
Contractor and subcontractor risks	4	5	9/03/2017 7:13 PM	AG	9/03/2017 9:18 PM	AG
Decision-making methodology	2	2	9/03/2017 7:15 PM	AG	9/03/2017 9:20 PM	AG
Environmental issues	2	2	9/03/2017 1:38 PM	AG	9/03/2017 9:21 PM	AG
Inadequate project management	8	15	9/03/2017 1:09 PM	AG	9/03/2017 8:02 PM	AG
Insufficient insurance	1	1	9/03/2017 8:14 PM	AG	9/03/2017 8:15 PM	AG
Insufficient quality assurance	4	4	9/03/2017 1:11 PM	AG	9/03/2017 8:10 PM	AG
Issues with getting correct site design information	1	1	9/03/2017 7:39 PM	AG	9/03/2017 7:55 PM	AG
Labour organisations and unions	1	1	27/02/2017 5:48 PM	AG	9/03/2017 1:07 PM	AG
Administrative groups	1	1	27/02/2017 5:49 PM	AG	27/02/2017 5:49 PM	AG
Financial groups	1	1	27/02/2017 5:49 PM	AG	27/02/2017 5:50 PM	AG
Labour groups	1	1	27/02/2017 5:49 PM	AG	27/02/2017 5:50 PM	AG
Trade unions	1	1	27/02/2017 5:52 PM	AG	28/02/2017 9:44 AM	AG
Lack of specification and documentation	2	2	9/03/2017 7:23 PM	AG	9/03/2017 7:37 PM	AG
Late supply of information	3	3	9/03/2017 7:31 PM	AG	10/03/2017 9:52 AM	AG
Legal issues	5	5	5/03/2017 8:26 PM	AG	9/03/2017 8:33 PM	AG
Licensing procedures	1	1	5/03/2017 8:26 PM	AG	5/03/2017 8:27 PM	AG
Missed deadlines	1	1	9/03/2017 2:01 PM	AG	9/03/2017 2:01 PM	AG
Poor quality product	4	4	9/03/2017 1:09 PM	AG	9/03/2017 7:54 PM	AG
Client satisfaction	2	2	9/03/2017 2:00 PM	AG	9/03/2017 7:54 PM	AG
Risk management issues	6	10	9/03/2017 7:12 PM	AG	9/03/2017 8:35 PM	AG
Schedule overrun	1	1	9/03/2017 8:03 PM	AG	9/03/2017 8:04 PM	AG
Scope change	5	10	25/02/2017 9:59 AM	AG	9/03/2017 9:25 PM	AG
Time delays	4	4	9/03/2017 1:33 PM	AG	9/03/2017 9:18 PM	AG
Delay in getting approval	6	7	5/03/2017 6:19 PM	AG	9/03/2017 9:24 PM	AG
Delays in insurance commitment	1	1	9/03/2017 1:50 PM	AG	9/03/2017 1:50 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Unable to resolve diputes	2	2	9/03/2017 1:15 PM	AG	9/03/2017 1:58 PM	AG
Unforseen conditions and situations	1	1	9/03/2017 1:52 PM	AG	9/03/2017 1:53 PM	AG
Waste management processes	1	1	5/03/2017 6:02 PM	AG	5/03/2017 6:03 PM	AG
Need for reclamation	1	1	5/03/2017 6:03 PM	AG	5/03/2017 6:04 PM	AG
Need for recycling	1	1	5/03/2017 6:04 PM	AG	5/03/2017 6:04 PM	AG
Waste dumped in desert	1	1	5/03/2017 6:03 PM	AG	5/03/2017 6:03 PM	AG
Weather risks	2	2	9/03/2017 1:08 PM	AG	9/03/2017 7:06 PM	AG
Resources and Technology	0	0	24/02/2017 10:24 AM	AG	14/05/2017 11:41 AM	MH
Delays in access to resources	2	2	9/03/2017 1:36 PM	AG	9/03/2017 7:52 PM	AG
Impacts	1	1	6/03/2017 4:48 PM	AG	6/03/2017 4:48 PM	AG
Lack of availability of resources	7	10	5/03/2017 6:08 PM	AG	9/03/2017 9:22 PM	AG
Scarcity of materials	3	4	9/03/2017 6:01 AM	AG	9/03/2017 12:55 PM	AG
Unavailability of specialist equipment	1	1	9/03/2017 1:35 PM	AG	9/03/2017 1:35 PM	AG
Risk allocation practices	0	0	27/02/2017 2:28 PM	AG	14/05/2017 11:41 AM	MH
Allocated to respective owner depending on best suitability to manage	3	5	3/03/2017 10:02 AM	AG	10/03/2017 1:18 PM	AG
Allocated or transferred to contractor	8	9	2/03/2017 12:30 PM	AG	10/03/2017 1:18 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Risks typically allocated to contractor	0	0	3/03/2017 10:04 AM	AG	4/03/2017 2:04 PM	AG
Completed facilities are fit for purpose	1	1	3/03/2017 10:11 AM	AG	3/03/2017 10:11 AM	AG
Completed facilities provide specific outputs	1	1	3/03/2017 10:10 AM	AG	3/03/2017 10:10 AM	AG
Cultural factors	1	1	4/03/2017 2:27 PM	AG	4/03/2017 2:27 PM	AG
Delegated hours and timely performance	2	2	3/03/2017 10:29 AM	AG	4/03/2017 2:27 PM	AG
Health and safety	1	1	4/03/2017 2:02 PM	AG	4/03/2017 2:03 PM	AG
More experienced or specialists can handle	0	0	3/03/2017 10:38 AM	AG	3/03/2017 10:40 AM	AG
Health risks	1	1	3/03/2017 10:40 AM	AG	3/03/2017 10:41 AM	AG
Project budget risks	3	3	3/03/2017 10:39 AM	AG	4/03/2017 2:26 PM	AG
Quality assurance	2	2	3/03/2017 10:40 AM	AG	4/03/2017 2:25 PM	AG
Schedule risks	2	2	3/03/2017 10:39 AM	AG	4/03/2017 2:25 PM	AG
Most risks for a fixed price	2	2	4/03/2017 2:10 PM	AG	4/03/2017 2:12 PM	AG
Consequences	0	0	4/03/2017 2:12 PM	AG	4/03/2017 2:12 PM	AG
Contractors don't bid at all - so prices rise	1	1	4/03/2017 2:13 PM	AG	4/03/2017 2:14 PM	AG
Costs of projects reported to be underestimated by 9% in Middle East	1	1	4/03/2017 2:15 PM	AG	4/03/2017 2:16 PM	AG
Prices are very high	1	1	4/03/2017 2:13 PM	AG	4/03/2017 2:13 PM	AG
Only when required and specified in project documents	1	1	3/03/2017 10:42 AM	AG	3/03/2017 10:43 AM	AG
Funding allocation	1	1	3/03/2017 10:43 AM	AG	3/03/2017 10:44 AM	AG
Safety	1	1	4/03/2017 2:02 PM	AG	4/03/2017 2:02 PM	AG
Those that are appropriate to contractor	2	2	3/03/2017 10:06 AM	AG	3/03/2017 10:09 AM	AG
Those that contractor has more skills to manage than client or owner	1	1	4/03/2017 2:08 PM	AG	4/03/2017 2:08 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Risks typically offset and managed	0	0	3/03/2017 10:12 AM	AG	3/03/2017 10:12 AM	AG
Conditions precedents	1	1	3/03/2017 10:36 AM	AG	3/03/2017 10:36 AM	AG
Contractors themselves	1	1	4/03/2017 2:16 PM	AG	4/03/2017 2:17 PM	AG
Insurance	2	2	3/03/2017 10:13 AM	AG	3/03/2017 10:36 AM	AG
Pre-contract due diligence	2	2	3/03/2017 10:12 AM	AG	3/03/2017 10:36 AM	AG
Strong contract	1	1	4/03/2017 2:06 PM	AG	4/03/2017 2:06 PM	AG
Project manager responsible for monitoring	3	3	3/03/2017 10:14 AM	AG	10/03/2017 1:10 PM	AG
Consequences for finance and scope	2	2	27/02/2017 4:24 PM	AG	3/03/2017 10:46 AM	AG
Key factor for funding evaluation	1	1	3/03/2017 10:47 AM	AG	3/03/2017 10:47 AM	AG
Currency hedging	1	1	2/03/2017 12:51 PM	AG	2/03/2017 12:52 PM	AG
Insurance	1	1	2/03/2017 12:50 PM	AG	2/03/2017 12:51 PM	AG
All risk insurance (physical damage insurance)	1	1	2/03/2017 12:56 PM	AG	2/03/2017 12:57 PM	AG
Full reinstatement value of project	1	1	2/03/2017 12:57 PM	AG	2/03/2017 12:58 PM	AG
Mark-up for ancillary	1	1	2/03/2017 12:58 PM	AG	2/03/2017 12:58 PM	AG
Amount depends on complexity of project	1	1	2/03/2017 1:02 PM	AG	2/03/2017 1:02 PM	AG
Decennial liability insurance	1	1	2/03/2017 1:08 PM	AG	2/03/2017 2:00 PM	AG
Defect or partial collapse	0	0	2/03/2017 2:01 PM	AG	2/03/2017 2:01 PM	AG
Delay in startup	1	1	3/03/2017 9:50 AM	AG	3/03/2017 9:50 AM	AG
Medical insurance for workers	1	1	2/03/2017 12:51 PM	AG	2/03/2017 12:51 PM	AG
Professional indemnity	1	1	2/03/2017 1:02 PM	AG	2/03/2017 1:02 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Most important for design consultants	1	1	2/03/2017 1:03 PM	AG	2/03/2017 1:03 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Required in UAE	1	1	2/03/2017 1:04 PM	AG	2/03/2017 1:04 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Public liability	1	1	2/03/2017 1:04 PM	AG	2/03/2017 1:05 PM	AG
Workers compensation	1	1	2/03/2017 1:05 PM	AG	2/03/2017 1:05 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not qualified on not able to respond	2	2	2/03/2017 12:40 PM	AG	2/03/2017 12:41 PM	AG
Process for risk allocation	0	0	10/03/2017 1:04 PM	AG	10/03/2017 1:06 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Mitigation	2	2	27/02/2017 4:25 PM	AG	10/03/2017 1:13 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Avoided	2	2	27/02/2017 4:29 PM	AG	10/03/2017 1:16 PM	AG
Higher impact risks are prioritised	1	1	3/03/2017 9:59 AM	AG	3/03/2017 9:59 AM	AG
Reduce impact of the risk on project	1	1	27/02/2017 4:25 PM	AG	27/02/2017 4:26 PM	AG
Reduce occurrence probability of event	1	1	27/02/2017 4:25 PM	AG	27/02/2017 4:26 PM	AG
Reduced and retained	4	4	27/02/2017 4:30 PM	AG	10/03/2017 1:16 PM	AG
Shared or transferred between parties	6	6	2/03/2017 12:43 PM	AG	10/03/2017 1:18 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk assessment	2	3	27/02/2017 3:55 PM	AG	10/03/2017 1:12 PM	AG
Risk identification	2	3	27/02/2017 3:55 PM	AG	10/03/2017 1:20 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
There is a lack of risk allocation practices	1	1	3/03/2017 9:52 AM	AG	3/03/2017 9:52 AM	AG
Risk allocation practices - best performance suggestions	0	0	2/03/2017 12:39 PM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Need for a properly structured risk assessment process	1	1	5/03/2017 5:57 PM	AG	5/03/2017 5:58 PM	AG
Partnering, risk sharing	9	9	2/03/2017 12:39 PM	AG	10/03/2017 8:10 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Equitable and risk-based allocation of liability	1	1	4/03/2017 2:20 PM	AG	4/03/2017 2:21 PM	AG
Results in lower costs	2	2	2/03/2017 12:40 PM	AG	10/03/2017 8:15 AM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Unsafe practices need to be mitigated	1	1	3/03/2017 9:54 AM	AG	3/03/2017 9:54 AM	AG
Risk management attitudes	1	2	28/02/2017 3:31 PM	AG	14/05/2017 11:41 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Seen as expensive use of time	1	1	28/02/2017 3:33 PM	AG	28/02/2017 3:33 PM	AG
Risk management performance in UAE	0	0	28/02/2017 12:03 PM	AG	14/05/2017 11:42 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Acceptable	1	1	28/02/2017 12:04 PM	AG	1/03/2017 7:22 PM	AG
Challenging	2	2	28/02/2017 12:59 PM	AG	28/02/2017 1:50 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Skills and experience needed	2	2	28/02/2017 1:39 PM	AG	28/02/2017 1:51 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Mixed	2	2	28/02/2017 12:59 PM	AG	28/02/2017 3:29 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not all conduct formal risk assessments	1	1	28/02/2017 1:42 PM	AG	28/02/2017 1:42 PM	AG
Range of project cultures	1	1	28/02/2017 1:43 PM	AG	28/02/2017 1:44 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Needs improvement	3	3	28/02/2017 12:59 PM	AG	28/02/2017 1:37 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Ministries and Estidamas	1	1	28/02/2017 1:05 PM	AG	28/02/2017 1:06 PM	AG
Safety factors	1	1	28/02/2017 1:38 PM	AG	28/02/2017 1:38 PM	AG
Young industry	0	0	28/02/2017 1:04 PM	AG	28/02/2017 1:05 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not performed well	4	4	28/02/2017 1:07 PM	AG	1/03/2017 7:25 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Resource and planning	1	1	28/02/2017 1:08 PM	AG	28/02/2017 1:10 PM	AG
Risk analysis	1	1	28/02/2017 1:09 PM	AG	28/02/2017 1:09 PM	AG
Risk identification and quantification	1	1	28/02/2017 1:08 PM	AG	28/02/2017 1:10 PM	AG
Risk response	1	1	28/02/2017 1:09 PM	AG	28/02/2017 1:10 PM	AG
Suggested improvements	0	0	28/02/2017 1:12 PM	AG	28/02/2017 1:13 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Different cultures appreciation	1	1	1/03/2017 7:26 PM	AG	1/03/2017 7:26 PM	AG
Exploratory study	1	1	28/02/2017 1:13 PM	AG	28/02/2017 1:14 PM	AG
Modern practices needed	2	2	1/03/2017 7:27 PM	AG	1/03/2017 7:30 PM	AG
Need for knowledge and experience	1	1	28/02/2017 1:12 PM	AG	28/02/2017 1:12 PM	AG
Need to conduct formal risk assessments	1	1	1/03/2017 7:33 PM	AG	1/03/2017 7:33 PM	AG
Work better with contractor	1	1	1/03/2017 7:25 PM	AG	1/03/2017 7:25 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not qualified to answer	1	1	28/02/2017 1:03 PM	AG	10/03/2017 8:16 AM	AG
Selecting a contractor	0	0	27/02/2017 4:32 PM	AG	14/05/2017 11:42 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Government policy (and some clients do this)	1	1	4/03/2017 3:15 PM	AG	4/03/2017 3:21 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Selection criteria	0	0	4/03/2017 3:16 PM	AG	4/03/2017 3:16 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Grading system	0	0	4/03/2017 3:17 PM	AG	4/03/2017 3:17 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Dealing with waste	1	1	4/03/2017 3:18 PM	AG	4/03/2017 3:19 PM	AG
Diversity	1	1	4/03/2017 3:19 PM	AG	4/03/2017 3:19 PM	AG
How much local employment is brought in	1	1	4/03/2017 3:20 PM	AG	4/03/2017 3:20 PM	AG
Safety	1	1	4/03/2017 3:19 PM	AG	4/03/2017 3:19 PM	AG
Sustainability initiatives	1	1	4/03/2017 3:17 PM	AG	4/03/2017 3:18 PM	AG
Sustainability policy	1	1	4/03/2017 3:17 PM	AG	4/03/2017 3:18 PM	AG
Sustainability practices	1	1	4/03/2017 3:17 PM	AG	4/03/2017 3:18 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Not qualified to respond	2	2	4/03/2017 2:57 PM	AG	4/03/2017 4:14 PM	AG
Pre-qualification process	4	4	27/02/2017 4:32 PM	AG	10/03/2017 9:04 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Financial stability and capability	2	2	27/02/2017 4:35 PM	AG	4/03/2017 4:19 PM	AG
Previous performance	4	4	27/02/2017 4:34 PM	AG	10/03/2017 9:05 AM	AG
Previous projects and experience	5	6	27/02/2017 4:33 PM	AG	10/03/2017 9:05 AM	AG
Quality reports	2	2	27/02/2017 4:34 PM	AG	4/03/2017 3:24 PM	AG

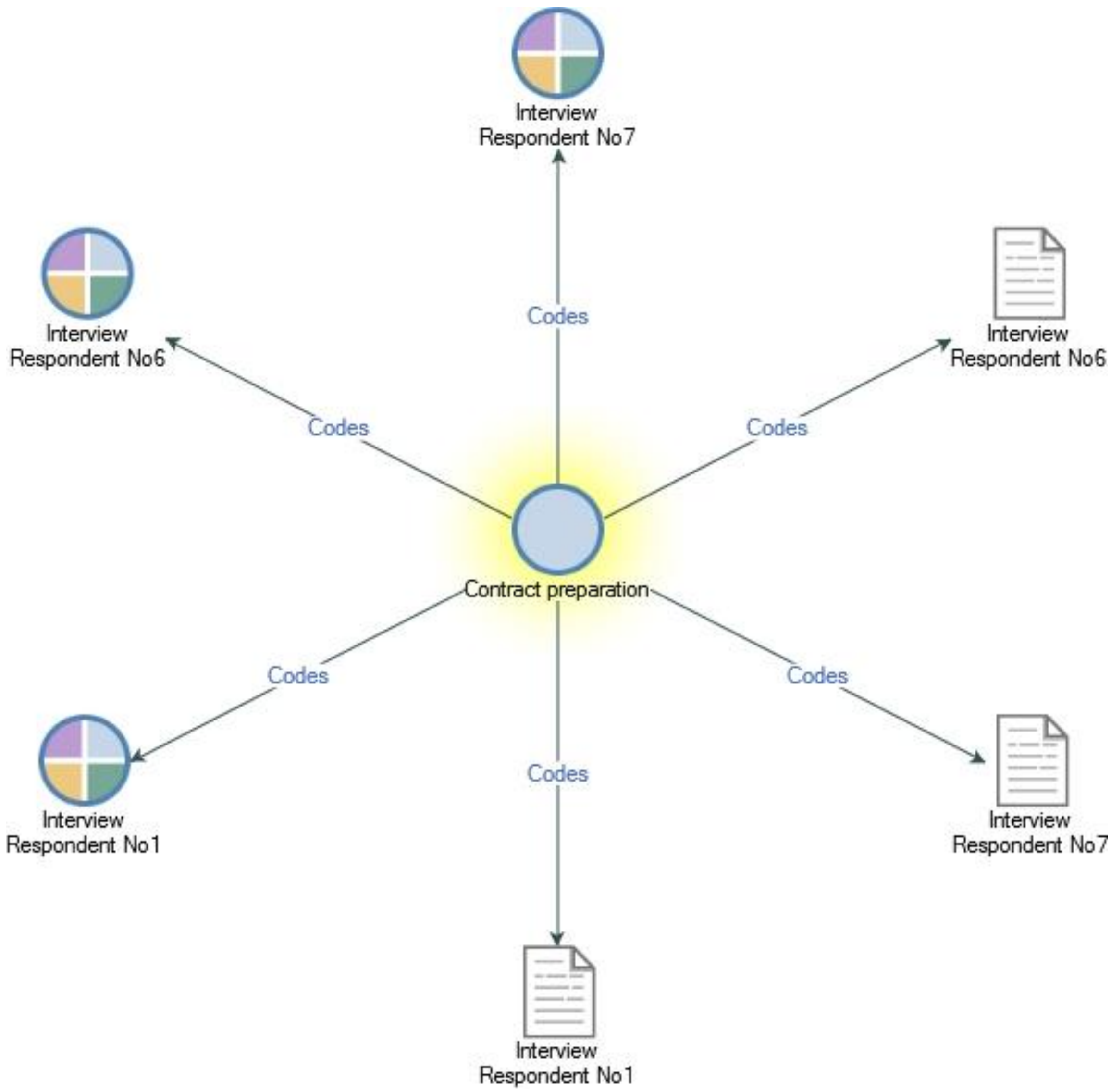
Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Reliability	2	2	27/02/2017 4:34 PM	AG	4/03/2017 3:24 PM	AG
Sizes of previous projects	2	2	27/02/2017 4:35 PM	AG	4/03/2017 3:24 PM	AG
Training, expertise, qualifications	4	4	4/03/2017 3:25 PM	AG	10/03/2017 9:05 AM	AG
Years of experience	4	4	4/03/2017 3:23 PM	AG	10/03/2017 9:05 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Price (one of the main indicators)	1	1	4/03/2017 2:58 PM	AG	4/03/2017 3:10 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cheaper tender wins	2	2	4/03/2017 3:05 PM	AG	4/03/2017 3:49 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Lots of variations	1	1	4/03/2017 3:51 PM	AG	4/03/2017 3:52 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cost client a lot more money	1	1	4/03/2017 3:52 PM	AG	4/03/2017 3:52 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
No foundation to see projects through	1	1	4/03/2017 3:07 PM	AG	4/03/2017 3:09 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Projects and companies went bust	1	1	4/03/2017 3:07 PM	AG	4/03/2017 3:08 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Work not done properly - no clause in contract for more money	1	1	4/03/2017 3:50 PM	AG	4/03/2017 3:51 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Larger developers prefer larger contractors	1	1	4/03/2017 3:03 PM	AG	4/03/2017 3:10 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Proven track record	1	1	4/03/2017 3:04 PM	AG	4/03/2017 3:05 PM	AG
Smaller companies - more risks	1	1	4/03/2017 3:05 PM	AG	4/03/2017 3:05 PM	AG
Worked with them before	1	1	4/03/2017 3:04 PM	AG	4/03/2017 3:04 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Recruitment agency	2	2	4/03/2017 3:25 PM	AG	4/03/2017 4:13 PM	AG
Rigorous contractor evaluation process	1	1	4/03/2017 3:35 PM	AG	4/03/2017 3:36 PM	AG
Suggestions for contractor selection	0	0	4/03/2017 3:54 PM	AG	4/03/2017 3:54 PM	AG

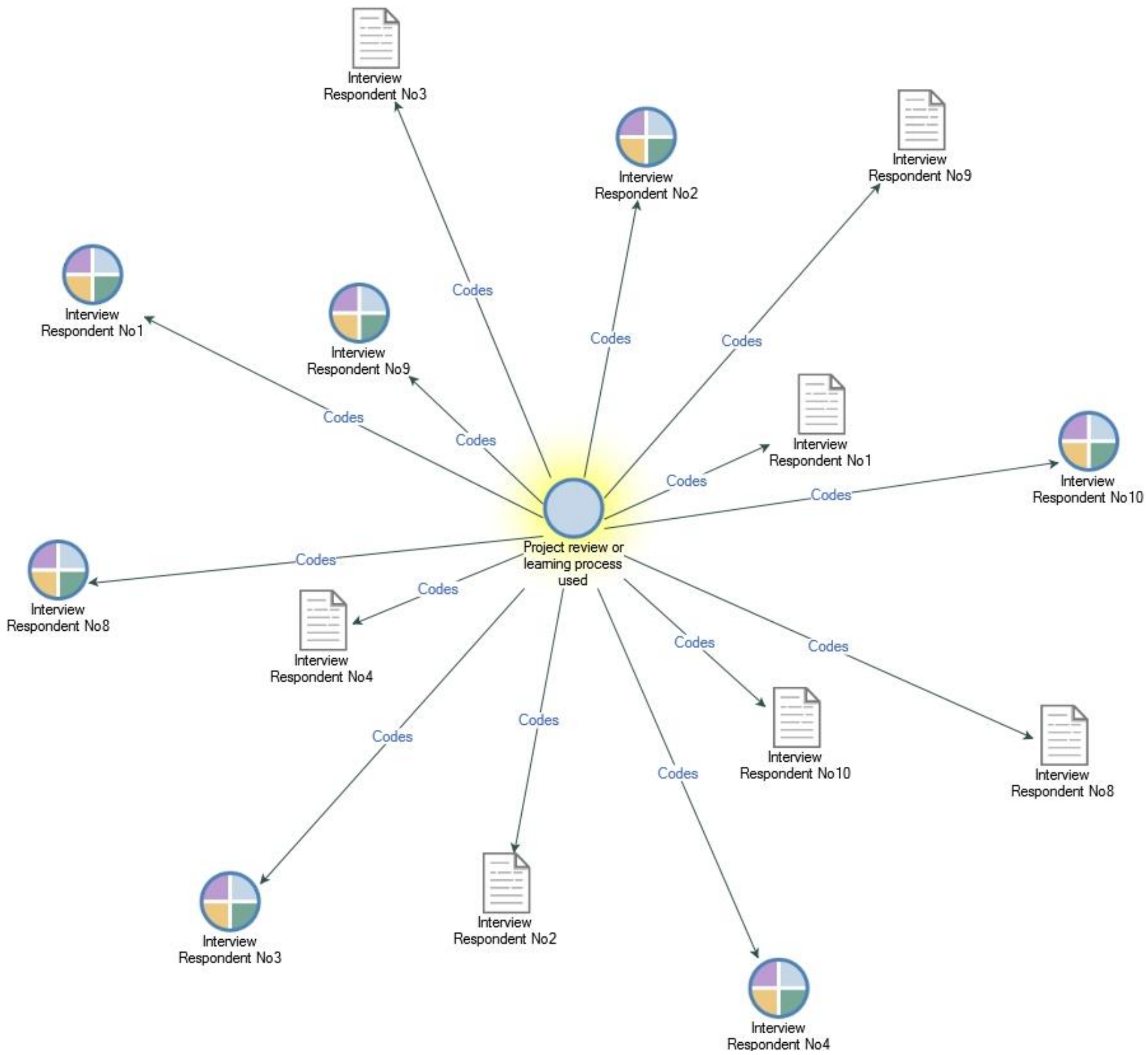
Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
More communication	1	1	4/03/2017 3:57 PM	AG	4/03/2017 3:57 PM	AG
More expensive but cheaper in long run as no variations	1	1	4/03/2017 3:55 PM	AG	4/03/2017 3:55 PM	AG
More flexibility from all parties	1	1	4/03/2017 3:56 PM	AG	4/03/2017 3:56 PM	AG
More horizontal working arrangement	1	1	4/03/2017 3:57 PM	AG	4/03/2017 3:58 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Tender	2	2	4/03/2017 3:31 PM	AG	4/03/2017 4:06 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Contractor submits proposal	1	1	4/03/2017 3:41 PM	AG	4/03/2017 3:41 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cost for execution of project	1	1	4/03/2017 3:43 PM	AG	4/03/2017 3:43 PM	AG
Plan for execution of project	1	1	4/03/2017 3:42 PM	AG	4/03/2017 3:42 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
High degree of rigour in evaluation	1	1	4/03/2017 2:55 PM	AG	4/03/2017 3:36 PM	AG
Participate in tenderer selection panel	1	1	4/03/2017 2:54 PM	AG	4/03/2017 3:36 PM	AG
Risk management components of tender documents	1	1	4/03/2017 2:51 PM	AG	4/03/2017 3:36 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Risk management experience and capability	1	1	4/03/2017 2:52 PM	AG	4/03/2017 2:52 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Success depends on	0	0	4/03/2017 3:44 PM	AG	4/03/2017 3:44 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Cost of execution	1	1	4/03/2017 3:44 PM	AG	4/03/2017 3:44 PM	AG
Performance	1	1	4/03/2017 3:45 PM	AG	4/03/2017 3:45 PM	AG
Years of experience	1	1	4/03/2017 3:44 PM	AG	4/03/2017 3:45 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Technical evaluation of tender responses related to risk management	1	1	4/03/2017 2:53 PM	AG	4/03/2017 3:36 PM	AG

Name	Sources	References	Created On	Created By	Modified On	Modified By
Name	Sources	References	Created On	Created By	Modified On	Modified By
Do both these factors have a significant influence	0	0	8/03/2017 2:24 PM	AG	10/03/2017 7:29 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Yes	11	18	8/03/2017 2:24 PM	AG	9/03/2017 6:20 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Knock on effects from other projects	1	1	8/03/2017 7:56 PM	AG	8/03/2017 7:57 PM	AG
Language issues	2	3	8/03/2017 8:04 PM	AG	9/03/2017 8:36 AM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Language barrier	2	2	8/03/2017 7:35 PM	AG	8/03/2017 8:05 PM	AG
Speak in native language and refuse interpreter	1	1	8/03/2017 7:37 PM	AG	8/03/2017 7:38 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Project management not effective	1	1	8/03/2017 2:25 PM	AG	8/03/2017 2:25 PM	AG
Risk management not effective	1	1	8/03/2017 2:25 PM	AG	8/03/2017 2:25 PM	AG
Stakeholder adjustment to scope	1	1	8/03/2017 2:24 PM	AG	8/03/2017 2:25 PM	AG
Size of projects interviewee involved in	0	0	5/03/2017 5:11 PM	AG	14/05/2017 11:42 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
1 billion or higher	8	8	5/03/2017 5:12 PM	AG	5/03/2017 5:20 PM	AG
Less than 1 billion	3	3	5/03/2017 5:12 PM	AG	5/03/2017 5:20 PM	AG
Strategies to improve economic and cultural factors	1	4	27/02/2017 4:08 PM	AG	14/05/2017 11:42 AM	MH
Name	Sources	References	Created On	Created By	Modified On	Modified By
Communication with stakeholder	1	1	27/02/2017 4:10 PM	AG	27/02/2017 4:13 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
be a good listener	1	1	27/02/2017 4:11 PM	AG	27/02/2017 4:14 PM	AG
get early information on change	1	1	27/02/2017 4:12 PM	AG	27/02/2017 4:14 PM	AG
respectful	1	1	27/02/2017 4:11 PM	AG	27/02/2017 4:13 PM	AG
stay close	1	2	27/02/2017 4:11 PM	AG	27/02/2017 4:14 PM	AG
Name	Sources	References	Created On	Created By	Modified On	Modified By
Review and analyse project monthly	1	1	27/02/2017 4:09 PM	AG	27/02/2017 4:09 PM	AG
Update plans according to changes	1	1	27/02/2017 4:09 PM	AG	27/02/2017 4:10 PM	AG

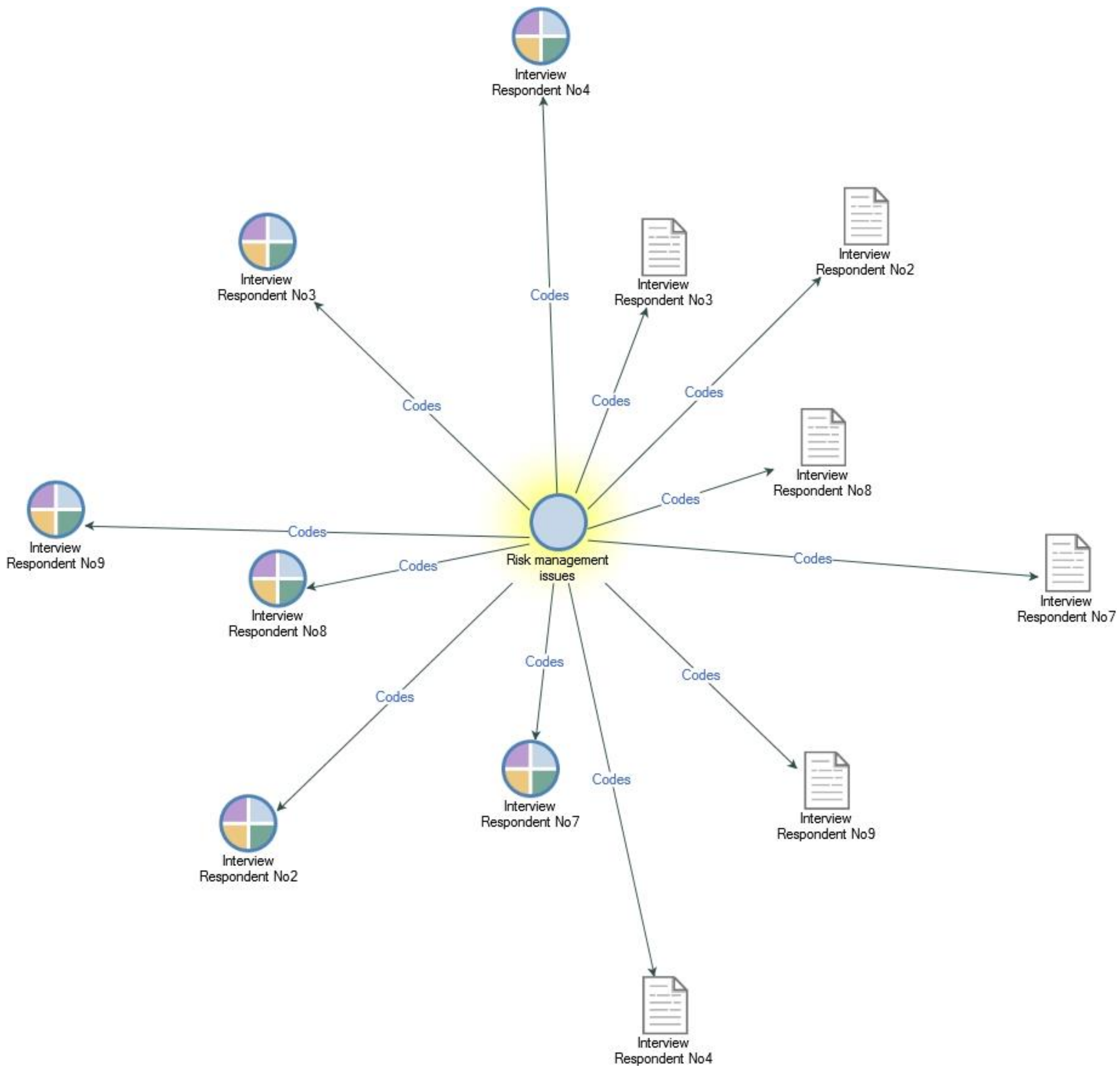
Name	Sources	References	Created On	Created By	Modified On	Modified By
UAE culture	9	27	24/02/2017 10:26 AM	AG	14/05/2017 11:42 AM	MH
Changing requirements without considering consequences	1	1	28/02/2017 10:25 AM	AG	28/02/2017 10:26 AM	AG
Onsite labour control	1	2	28/02/2017 10:11 AM	AG	1/03/2017 8:29 PM	AG
Performance and reward	1	1	1/03/2017 7:46 PM	AG	1/03/2017 7:47 PM	AG
Risk avoidance or overlooking	2	2	9/03/2017 8:42 AM	AG	9/03/2017 12:14 PM	AG
Start project and worry about problems later	1	1	5/03/2017 8:20 PM	AG	5/03/2017 8:20 PM	AG
Trust	3	3	6/03/2017 4:48 PM	AG	9/03/2017 10:03 AM	AG
Vertical hierarchy structure	7	7	28/02/2017 10:35 AM	AG	8/03/2017 2:52 PM	AG
Western workers	1	6	27/02/2017 3:26 PM	AG	10/03/2017 10:07 AM	AG
A lot of Western workers	1	1	27/02/2017 3:28 PM	AG	1/03/2017 7:44 PM	AG
Golden rules for Westerners	1	4	27/02/2017 3:30 PM	AG	1/03/2017 8:29 PM	AG
Remember they are guests	1	1	27/02/2017 3:31 PM	AG	27/02/2017 3:31 PM	AG
Retain focus on culture	1	2	27/02/2017 3:32 PM	AG	1/03/2017 8:29 PM	AG
Understand cultural impact by stakeholders on scope and project management	1	1	27/02/2017 3:33 PM	AG	5/03/2017 7:07 PM	AG
Lack of understanding and respect of culture	1	1	27/02/2017 3:27 PM	AG	1/03/2017 7:45 PM	AG
Work volume	1	1	25/02/2017 9:43 AM	AG	14/05/2017 11:42 AM	MH

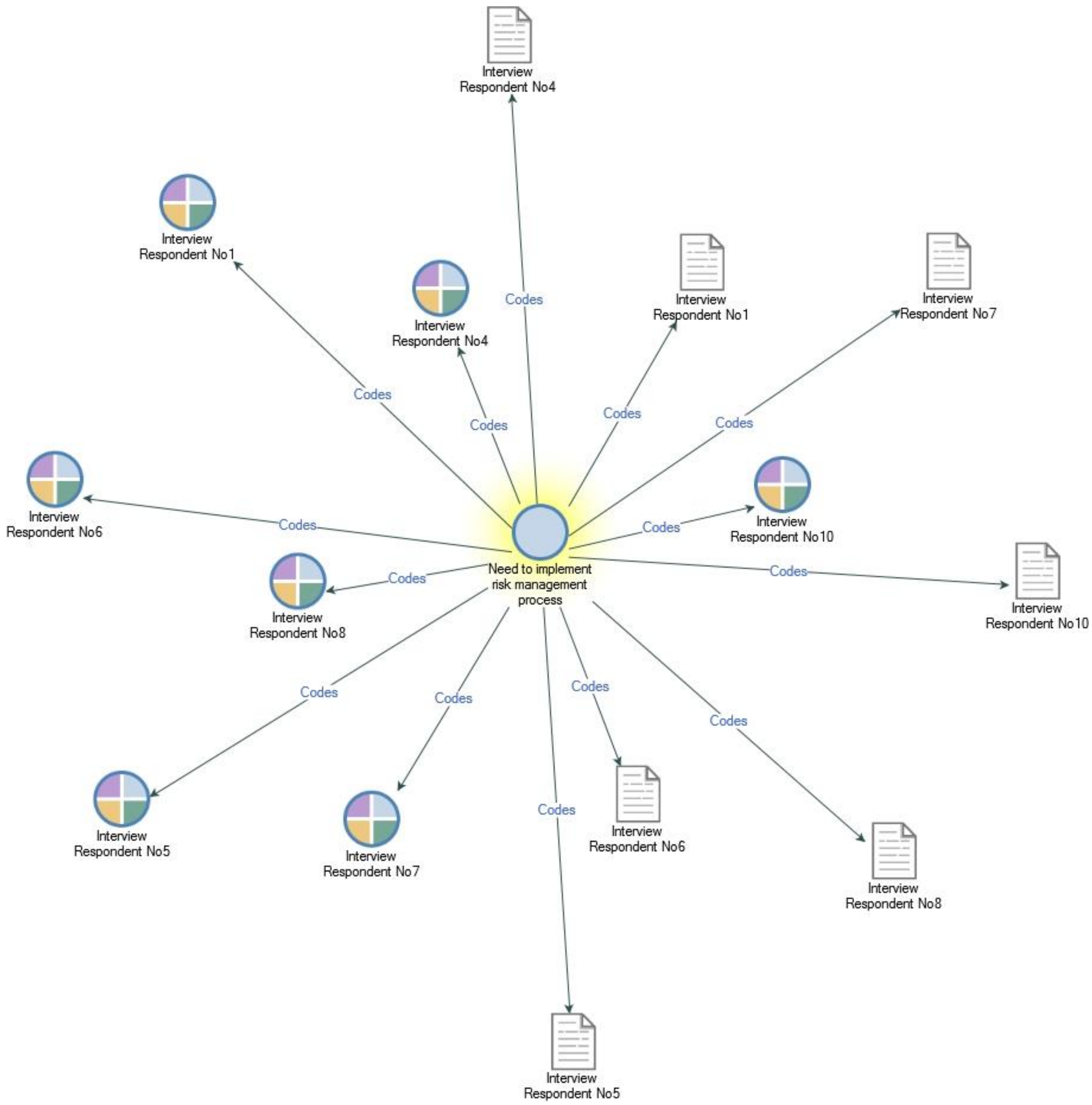
1.3 An Example of Nodes Coding

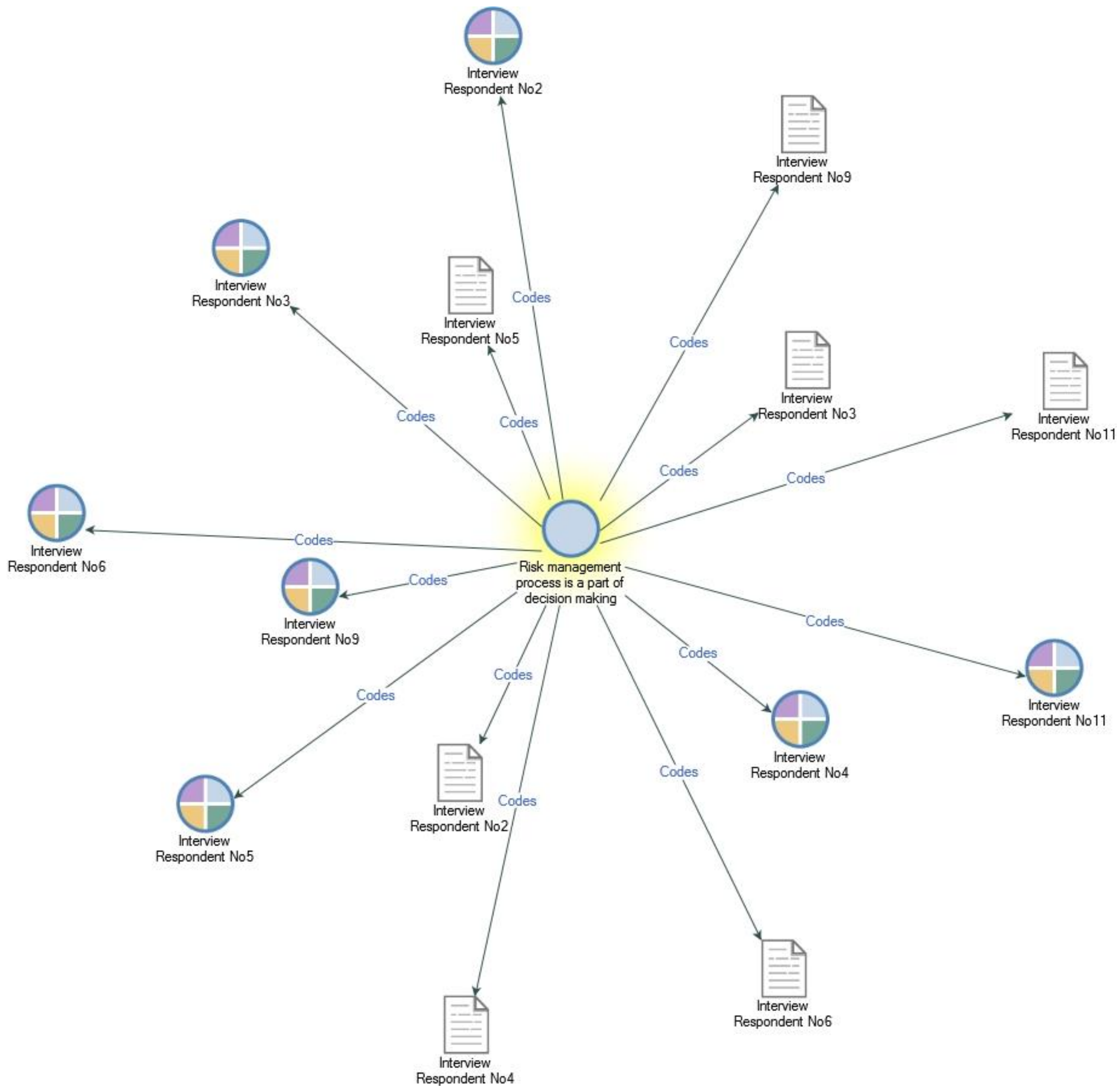

Interview
Respondent No7
Interview
Respondent No6
Interview
Respondent No6
Codes
Codes
Codes
Contract preparation
Codes
Codes
Codes
Interview
Respondent No1
Interview
Respondent No7
Interview
Respondent No1

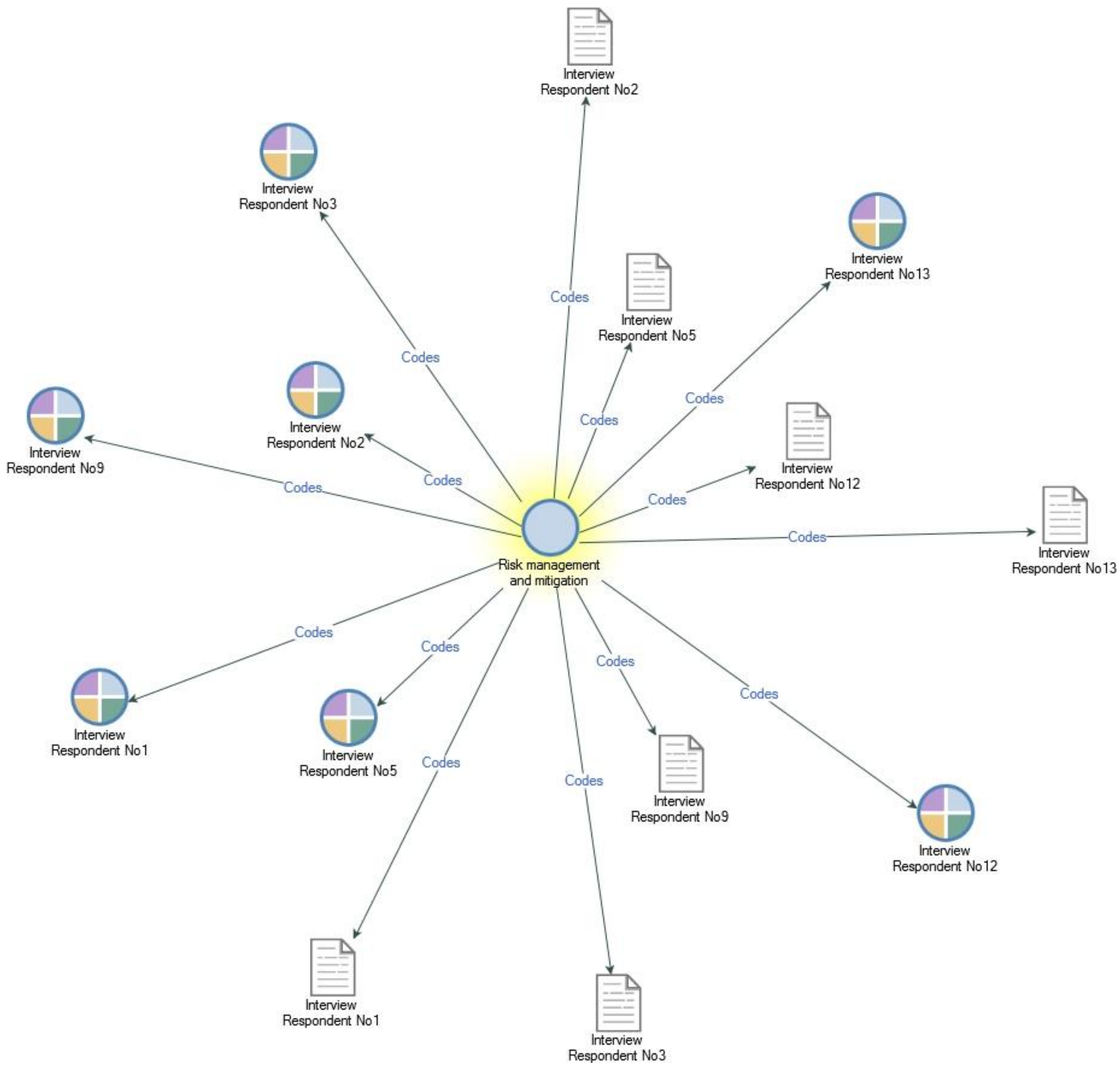


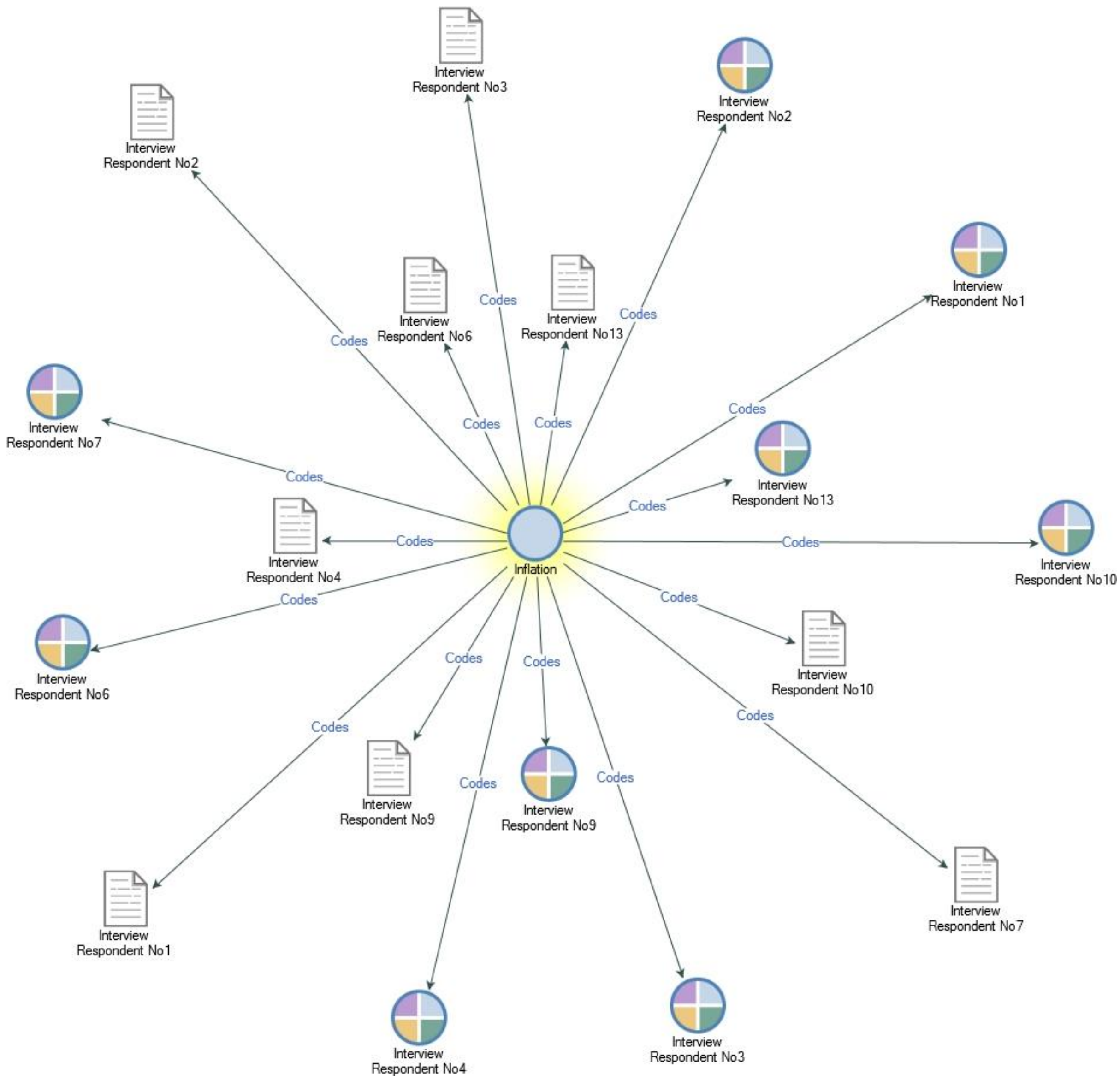
Interview
Respondent No3
Interview
Respondent No2
Interview
Respondent No9
Interview
Respondent No1
Interview
Respondent No9
Codes
Codes
Codes
Codes
Codes
Interview
Respondent No1
Codes
Codes
Interview
Respondent No10
Interview
Respondent No8
Codes
Project review or
learning process
used
Codes
Interview
Respondent No4
Codes
Codes
Codes
Codes
Codes
Interview
Respondent No10
Interview
Respondent No8
Interview
Respondent No3
Interview
Respondent No2
Interview
Respondent No4

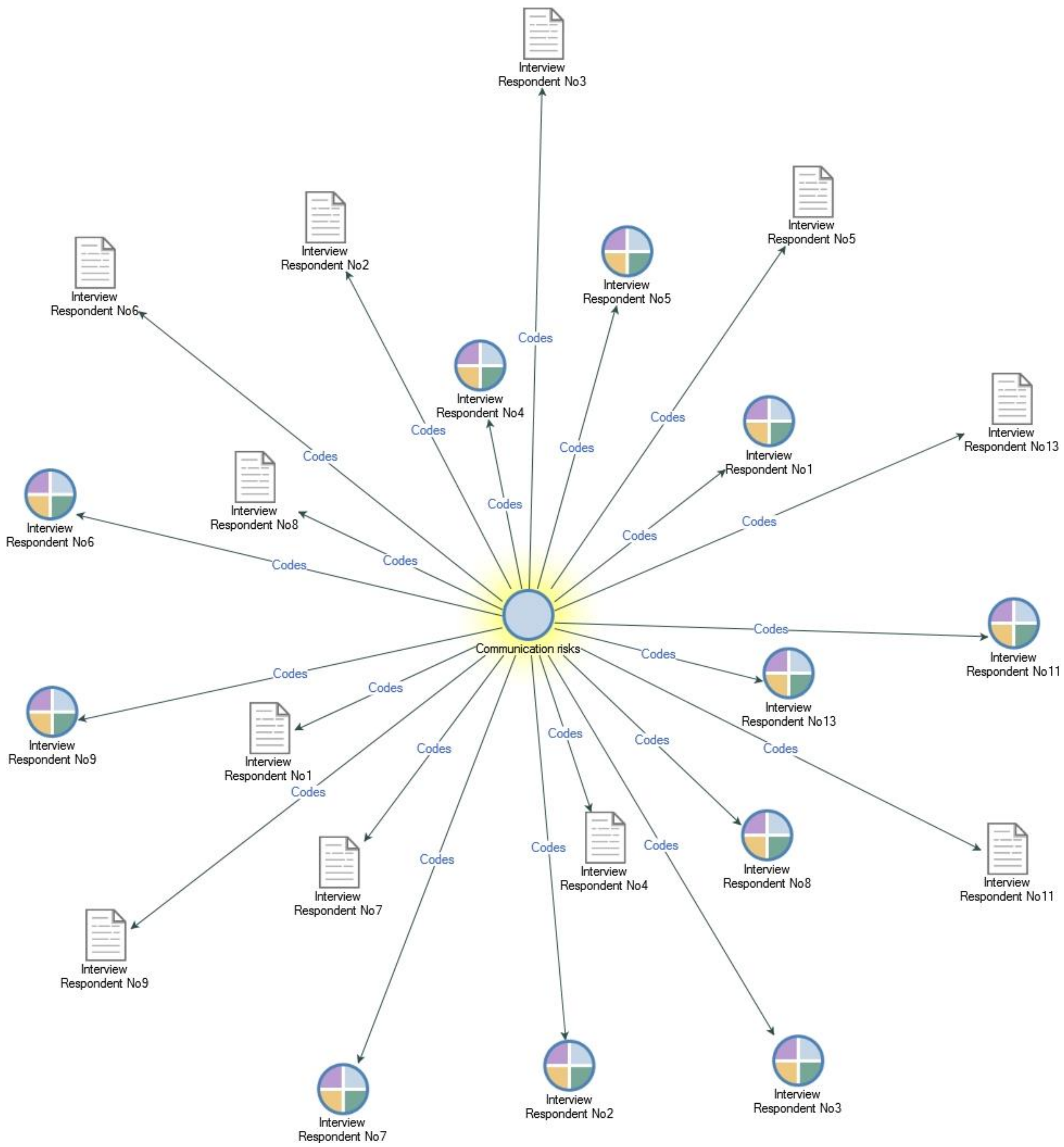

Interview
Respondent No4
Interview
Respondent No3
Codes
Interview
Respondent No3
Interview
Respondent No2
Codes
Codes
Codes
Interview
Respondent No8
Codes
Interview
Respondent No9
Codes
Codes
Risk management
issues
Codes
Interview
Respondent No7
Interview
Respondent No8
Codes
Codes
Codes
Interview
Respondent No7
Codes
Interview
Respondent No9
Interview
Respondent No2
Interview
Respondent No4

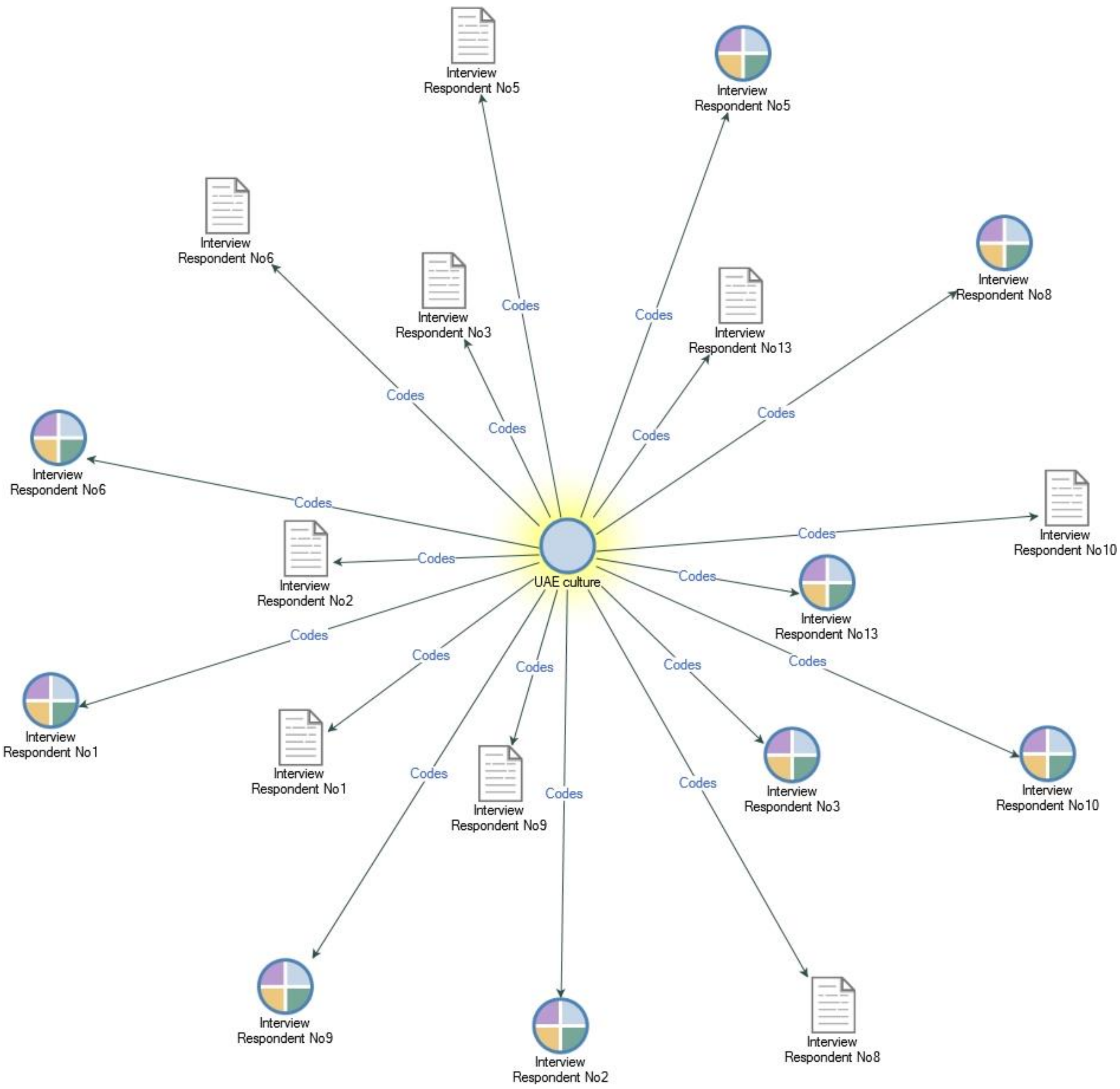

Interview
Respondent No4
Interview
Respondent No1
Interview
Respondent No4
Interview
Respondent No1
Interview
Respondent No7
Codes
Interview
Respondent No6
Interview
Respondent No10
Need to implement
risk management
process
Interview
Respondent No8
Interview
Respondent No10
Interview
Respondent No5
Interview
Respondent No7
Interview
Respondent No6
Interview
Respondent No8
Interview
Respondent No5


Interview
Respondent No2
Interview
Respondent No9
Interview
Respondent No3
Interview
Respondent No5
Codes
Codes
Interview
Respondent No3
Interview
Respondent No11
Codes
Codes
Codes
Codes
Codes
Interview
Respondent No6
Codes
Codes
Risk management
process is a part of
decision making
Interview
Respondent No9
Codes
Codes
Codes
Codes
Interview
Respondent No11
Interview
Respondent No4
Codes
Interview
Respondent No5
Interview
Respondent No2
Codes
Interview
Respondent No6
Interview
Respondent No4

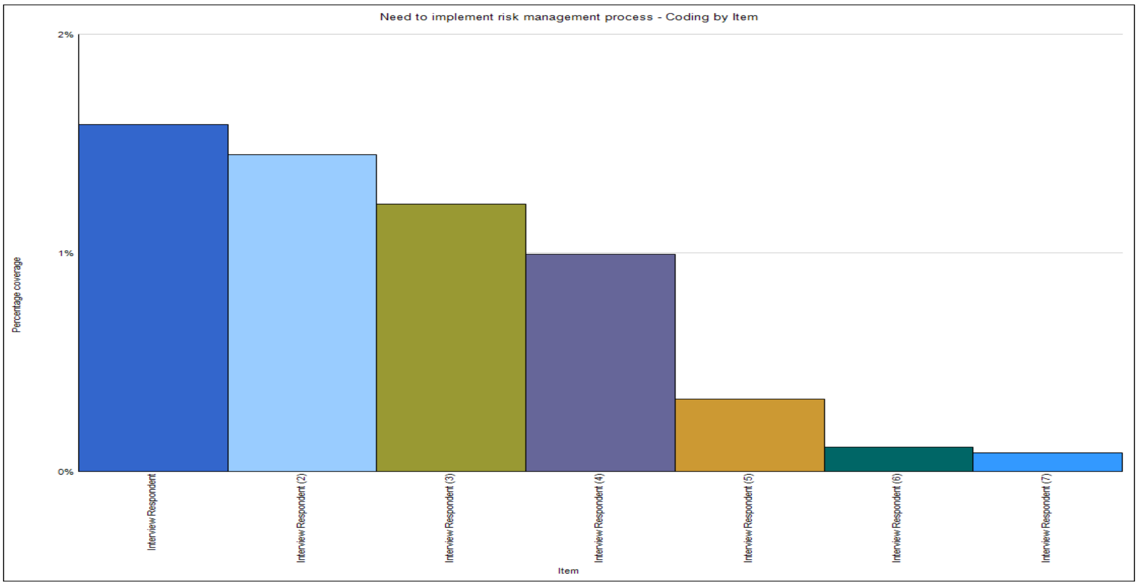

Interview
Respondent No2
Interview
Respondent No3
Interview
Respondent No13
Interview
Respondent No5
Interview
Respondent No2
Interview
Respondent No9
Interview
Respondent No12
Interview
Respondent No13
Risk management
and mitigation
Interview
Respondent No1
Interview
Respondent No5
Interview
Respondent No9
Interview
Respondent No12
Interview
Respondent No1
Interview
Respondent No3
Codes

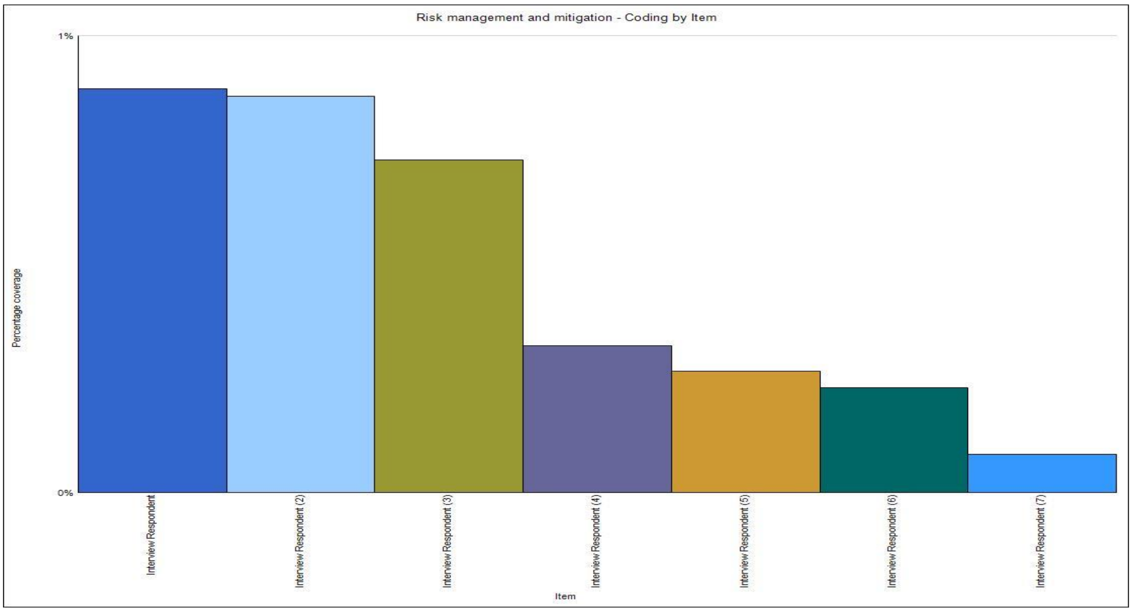

Interview
Respondent No3
Interview
Respondent No2
Interview
Respondent No2
Interview
Respondent No1
Interview
Respondent No6
Interview
Respondent No13
Interview
Respondent No7
Interview
Respondent No13
Interview
Respondent No4
Inflation
Interview
Respondent No10
Interview
Respondent No6
Interview
Respondent No10
Interview
Respondent No9
Interview
Respondent No9
Interview
Respondent No1
Interview
Respondent No7
Interview
Respondent No4
Interview
Respondent No3
Codes

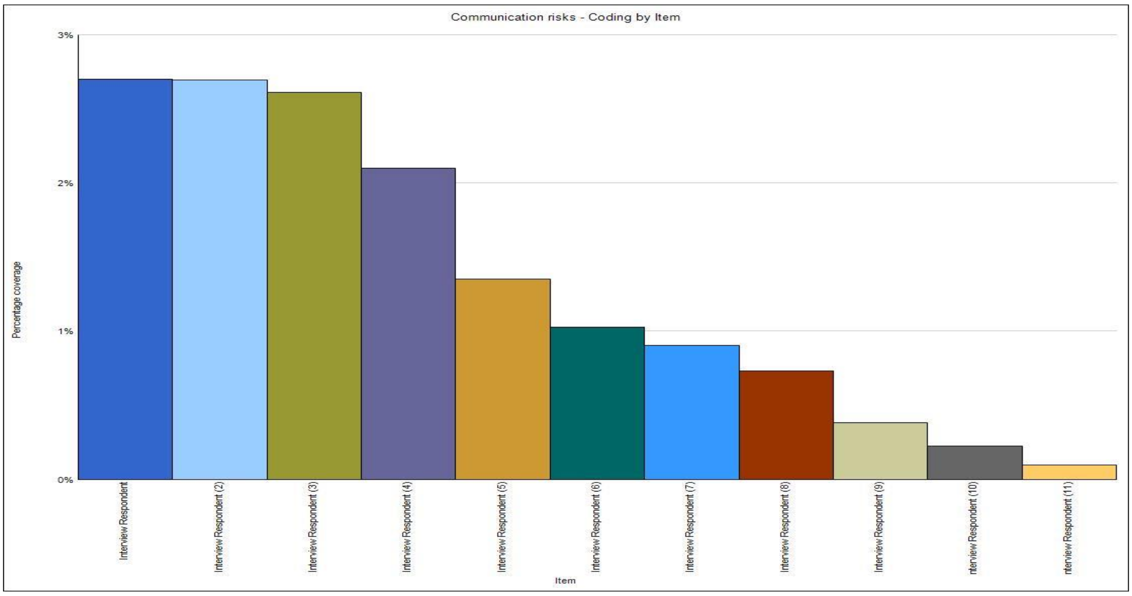

Communication risks
Codes
Interview Respondent No1
Interview Respondent No2
Interview Respondent No3
Interview Respondent No4
Interview Respondent No5
Interview Respondent No6
Interview Respondent No7
Interview Respondent No8
Interview Respondent No9
Interview Respondent No11
Interview Respondent No13

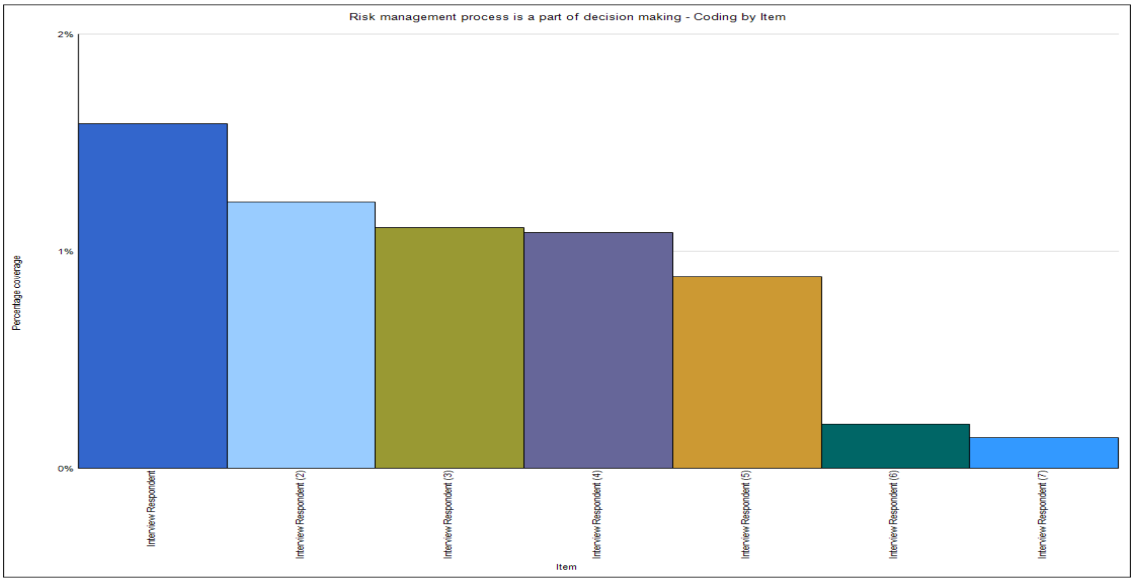


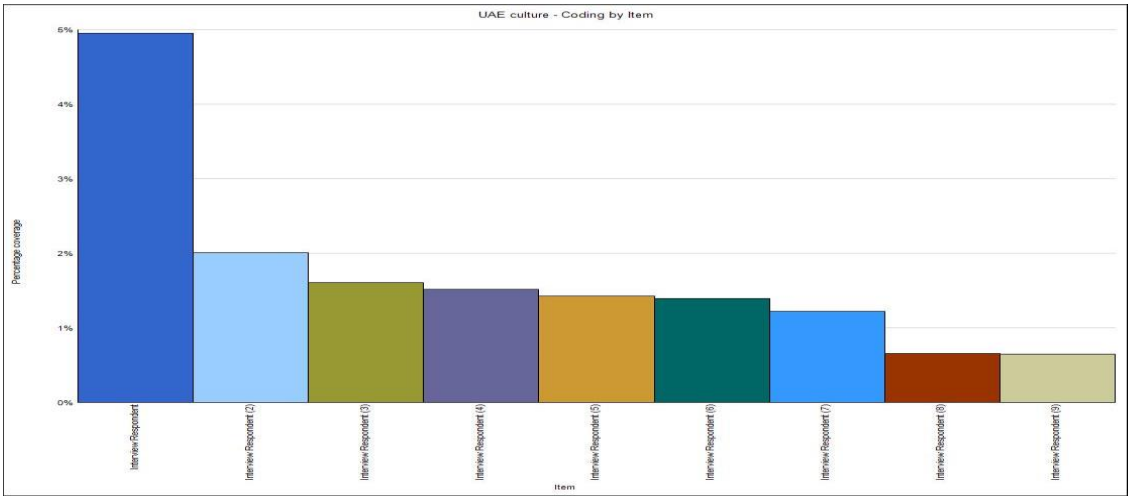
1.4 An Example of Precentage Nodes Coding by Item

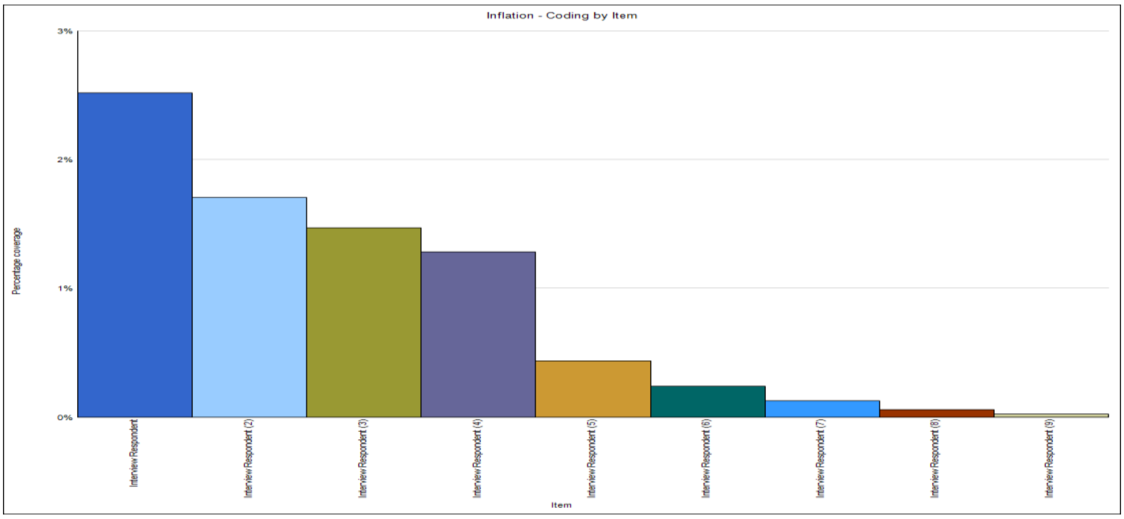


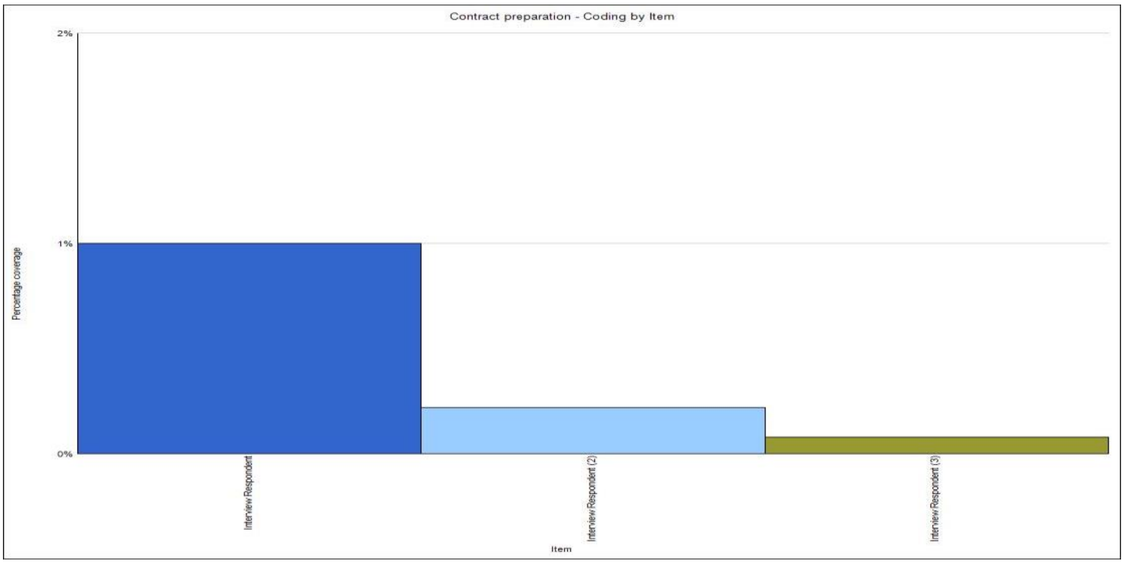

Risk management and mitigation - Coding by Item
1%
0%
Percentage coverage
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)
Interview Respondent (4)
Interview Respondent (5)
Interview Respondent (6)
Interview Respondent (7)
Item


Communication risks - Coding by Item
3%
2%
1%
0%
Percentage coverage
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)
Interview Respondent (4)
Interview Respondent (5)
Interview Respondent (6)
Interview Respondent (7)
Interview Respondent (8)
Interview Respondent (9)
nterview Respondent (10)
nterview Respondent (11)
Item


Risk management process is a part of decision making - Coding by Item
2%
1%
0%
Percentage coverage
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)
Interview Respondent (4)
Interview Respondent (5)
Interview Respondent (6)
Interview Respondent (7)
Item


UAE culture - Coding by Item
Percentage coverage
Item
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)
Interview Respondent (4)
Interview Respondent (5)
Interview Respondent (6)
Interview Respondent (7)
Interview Respondent (8)
Interview Respondent (9)


Inflation - Coding by Item
3%
2%
1%
0%
Percentage coverage
Item
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)
Interview Respondent (4)
Interview Respondent (5)
Interview Respondent (6)
Interview Respondent (7)
Interview Respondent (8)
Interview Respondent (9)


Contract preparation - Coding by Item
2%
1%
0%
Percentage coverage
Item
Interview Respondent
Interview Respondent (2)
Interview Respondent (3)

1.5 Nodes Compared by Number of Coded

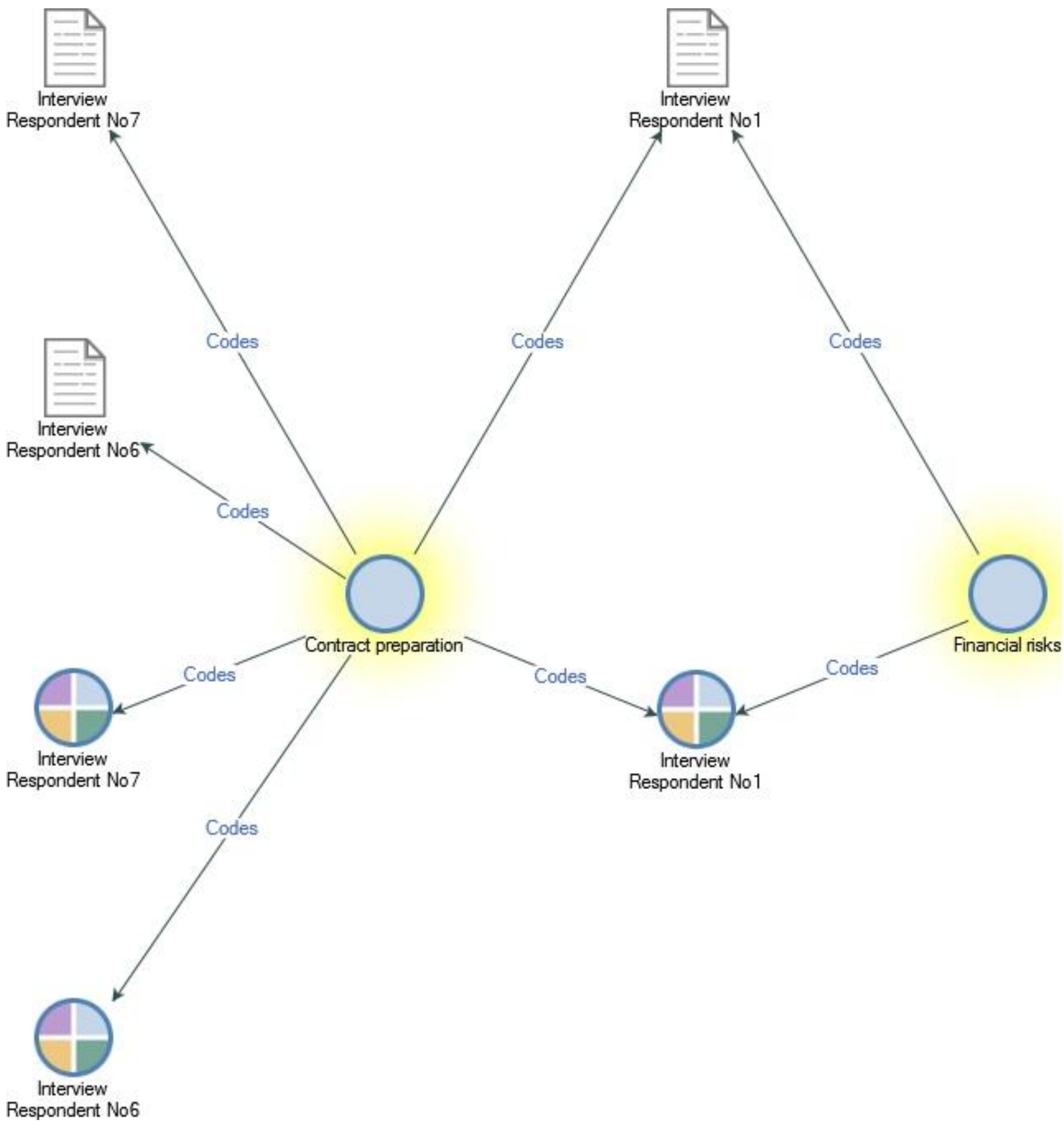
Nodes

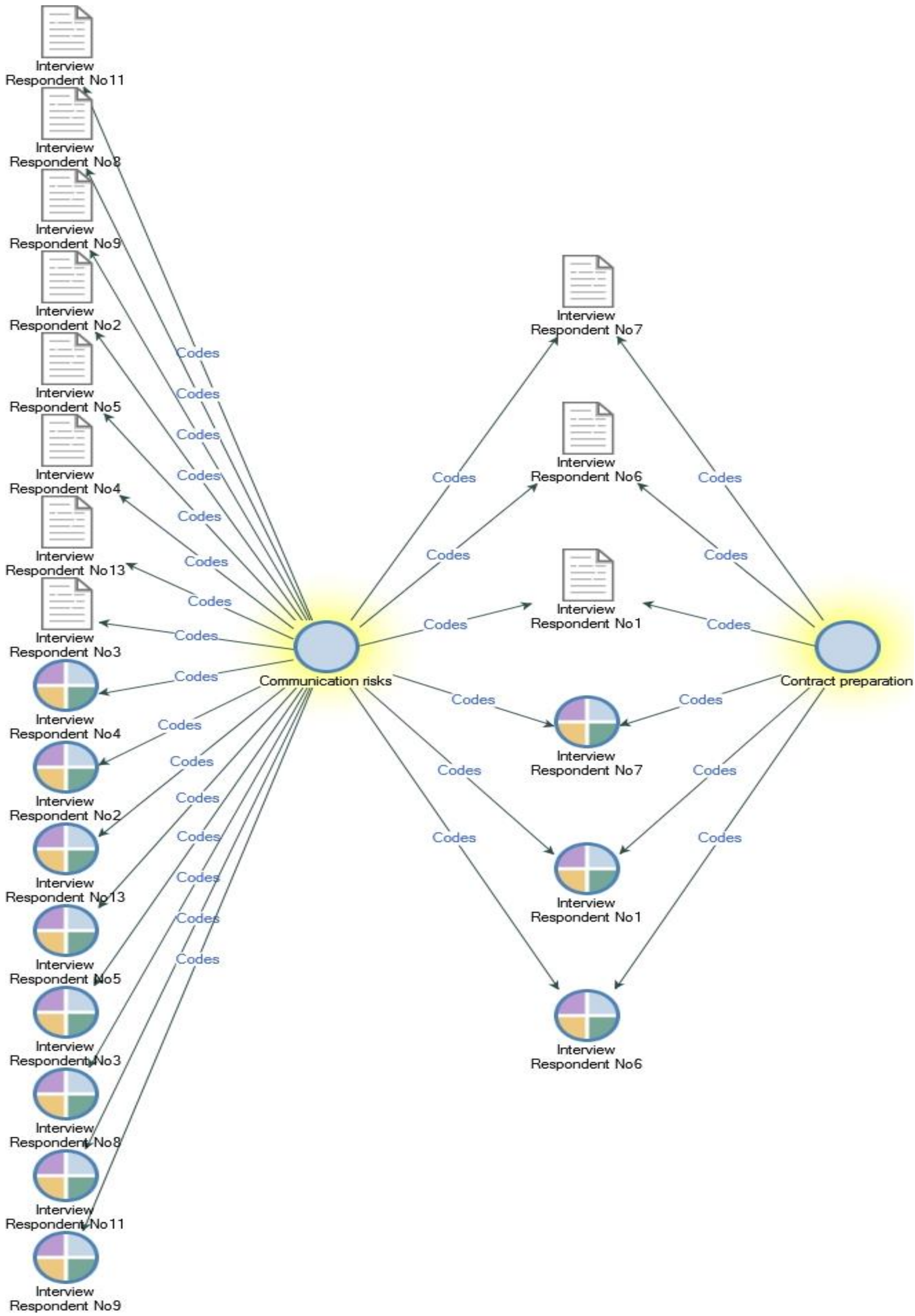
Name	Sources	Referen
Communication risks	11	24
Contract preparation	3	4
Cultural diversity	0	0
Current relationships	0	0
Current risk management practices	0	0
Decision making and planning pro	0	0
External risks	0	0
Financial risks	1	8
Financing of construction projects	0	0
Improvements for Risk Manageme	0	0
Internal risks	0	0
Learning Process of what happene	0	0
Other risks	0	0
Resources and Technology	0	0
Risk allocation practices	0	0
Risk allocation practices - best perf	0	0
Risk management attitudes	1	2
Risk management performance in	0	0
Selecting a contractor	0	0
Significance of economic and cultu	0	0
Size of projects interviewee involve	0	0
Strategies to improve economic an	1	4
UAE culture	9	27
Work volume	1	1

Nodes compared by number of

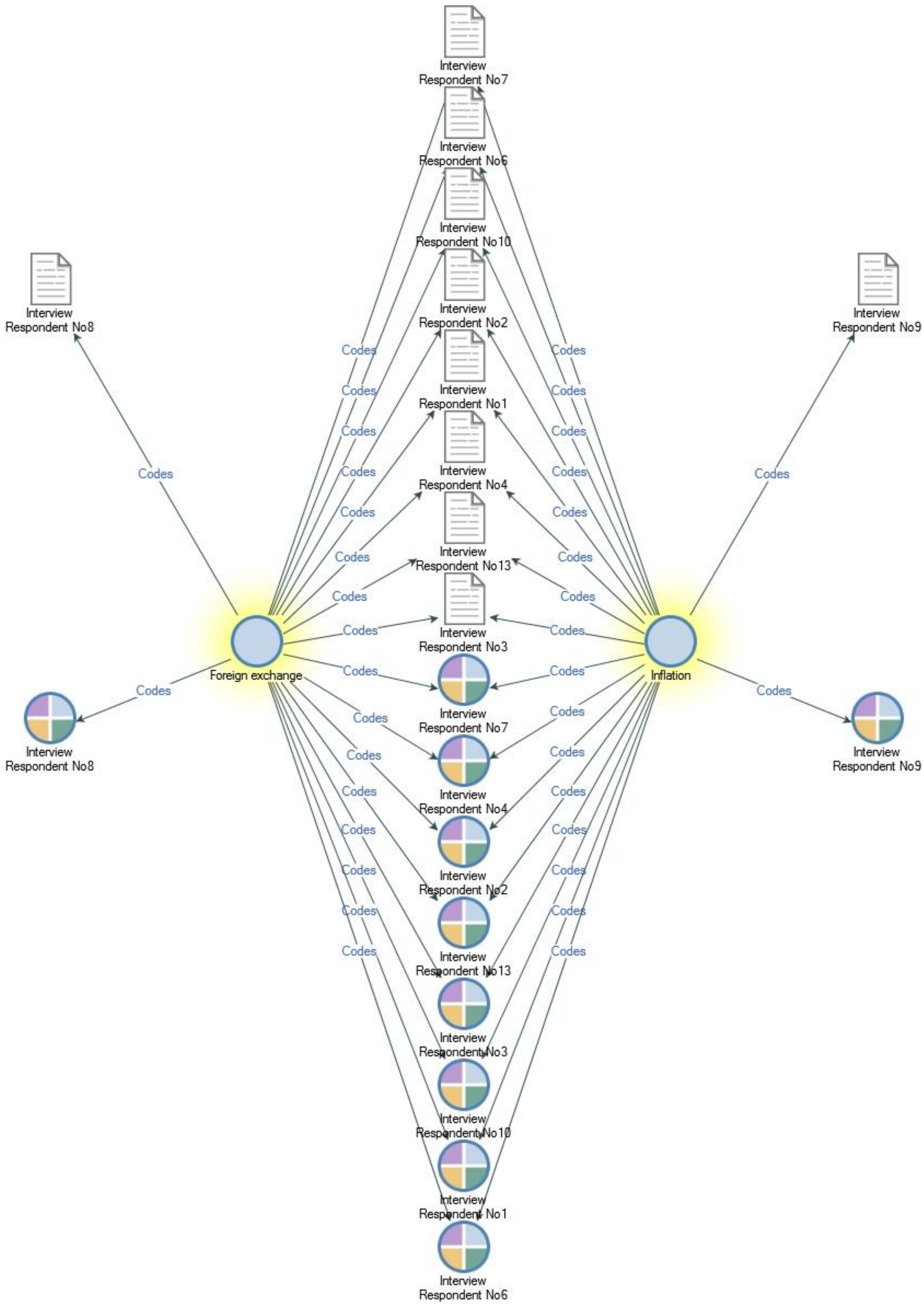
Nodes	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded
Nodes\\Communication risks	24	25	11	11
Nodes\\Communication risks\Culturally specific communication risks\Quiet approach to handling probl	1	1	1	1
Nodes\\Contract preparation\Impact\Cost overruns	1	1	1	1
Nodes\\Contract preparation\Incomplete contract document	1	1	1	1
Nodes\\Contract preparation\Unclear objectives	2	2	2	2
Nodes\\Contract preparation\Unclear roles and responsibilities	1	1	1	1
Nodes\\Cultural diversity\Custom differences	3	3	3	3
Nodes\\Cultural diversity\Decision making processes\Different decision making processes	4	4	4	4
Nodes\\Cultural diversity\Decision making processes\Poor experience in decision making processes	2	2	2	2
Nodes\\Cultural diversity\Different dispute resolution	1	1	1	1
Nodes\\Cultural diversity\Different language	13	13	9	9
Nodes\\Cultural diversity\Different ways of thinking	1	1	1	1
Nodes\\Cultural diversity\Emiritisation process	2	2	2	2
Nodes\\Cultural diversity\Employment of women - success	1	1	1	1
Nodes\\Cultural diversity\High turnover of employment	2	3	1	1
Nodes\\Cultural diversity\High turnover of employment\Lack of depth in technical knowledge	1	1	1	1
Nodes\\Cultural diversity\Lots of expatriate workers	5	7	4	4
Nodes\\Cultural diversity\Lots of expatriate workers\Competition with other companies	1	1	1	1
Nodes\\Cultural diversity\Lots of expatriate workers\Limited pool of talent	1	1	1	1
Nodes\\Current relationships\Blame culture	2	2	1	1
Nodes\\Current relationships\Consultants\Face financial risks	1	3	1	1
Nodes\\Current relationships\Consultants\Face financial risks\Delay	1	1	1	1
Nodes\\Current relationships\Consultants\Face financial risks\Design changes	1	1	1	1
Nodes\\Current relationships\Contractors\Allocated all risks associated with work	3	3	3	3
Nodes\\Current relationships\Contractors\Face financial risks	2	6	2	4
Nodes\\Current relationships\Contractors\Face financial risks\Contract clause - offset risk of non-paym	1	1	1	1
Nodes\\Current relationships\Contractors\Face financial risks\Delay of financial resources	1	1	1	1
Nodes\\Current relationships\Contractors\Face financial risks\Late payment by client	2	2	2	2
Nodes\\Current relationships\Limited financial backing	1	1	1	1
Nodes\\Current relationships\Suggestions\Close relationship with all key stakeholders	2	2	2	2
Nodes\\Current relationships\Suggestions\Professional at all times	1	1	1	1
Nodes\\Current relationships\Suggestions\Team work - consider different perspectives	2	2	2	2
Nodes\\Current relationships\With client\Conflicting	4	4	4	4
Nodes\\Current relationships\With client\Negative	3	3	3	3

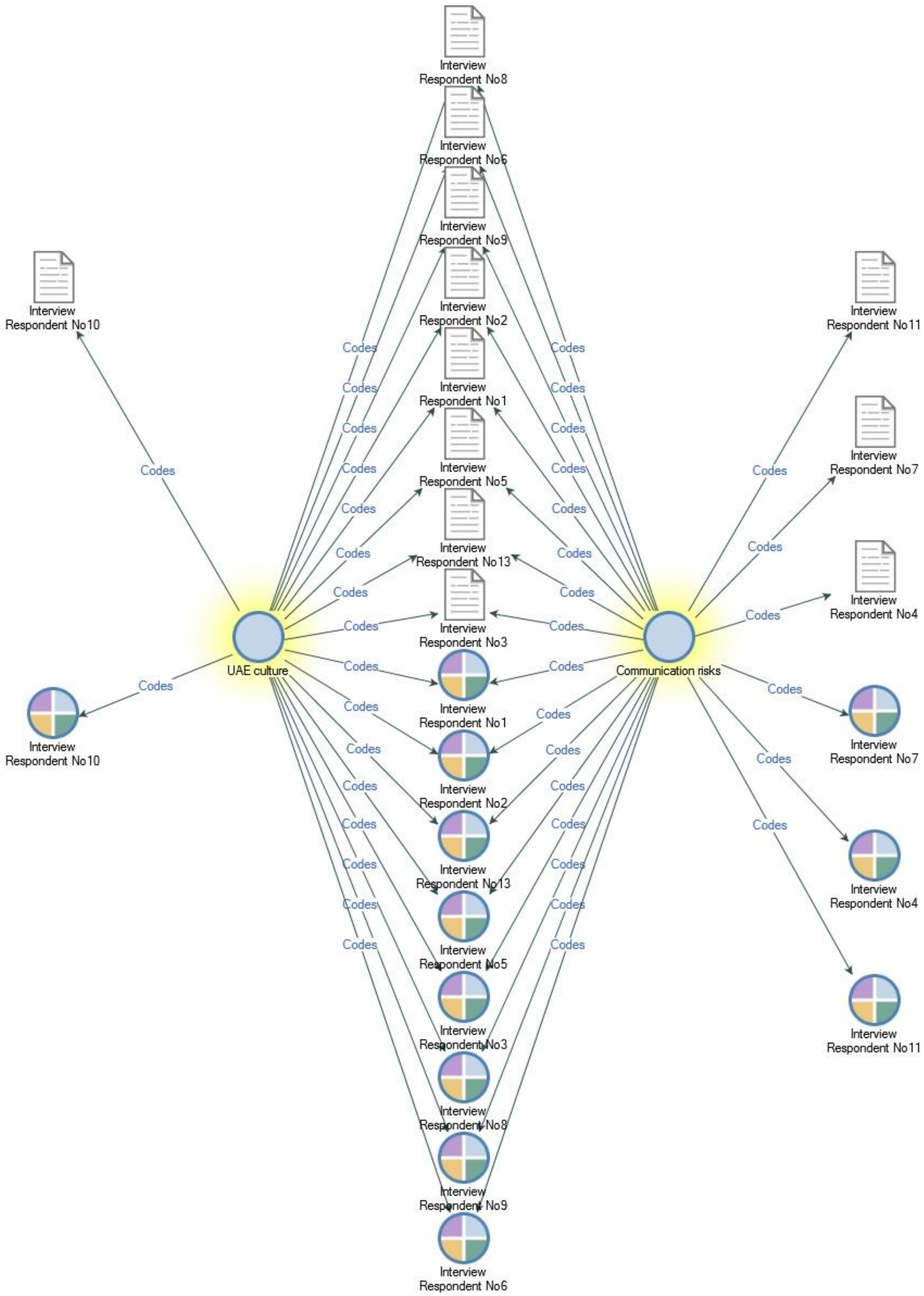
1.6 An example of Nodes Compared by Number of Coded



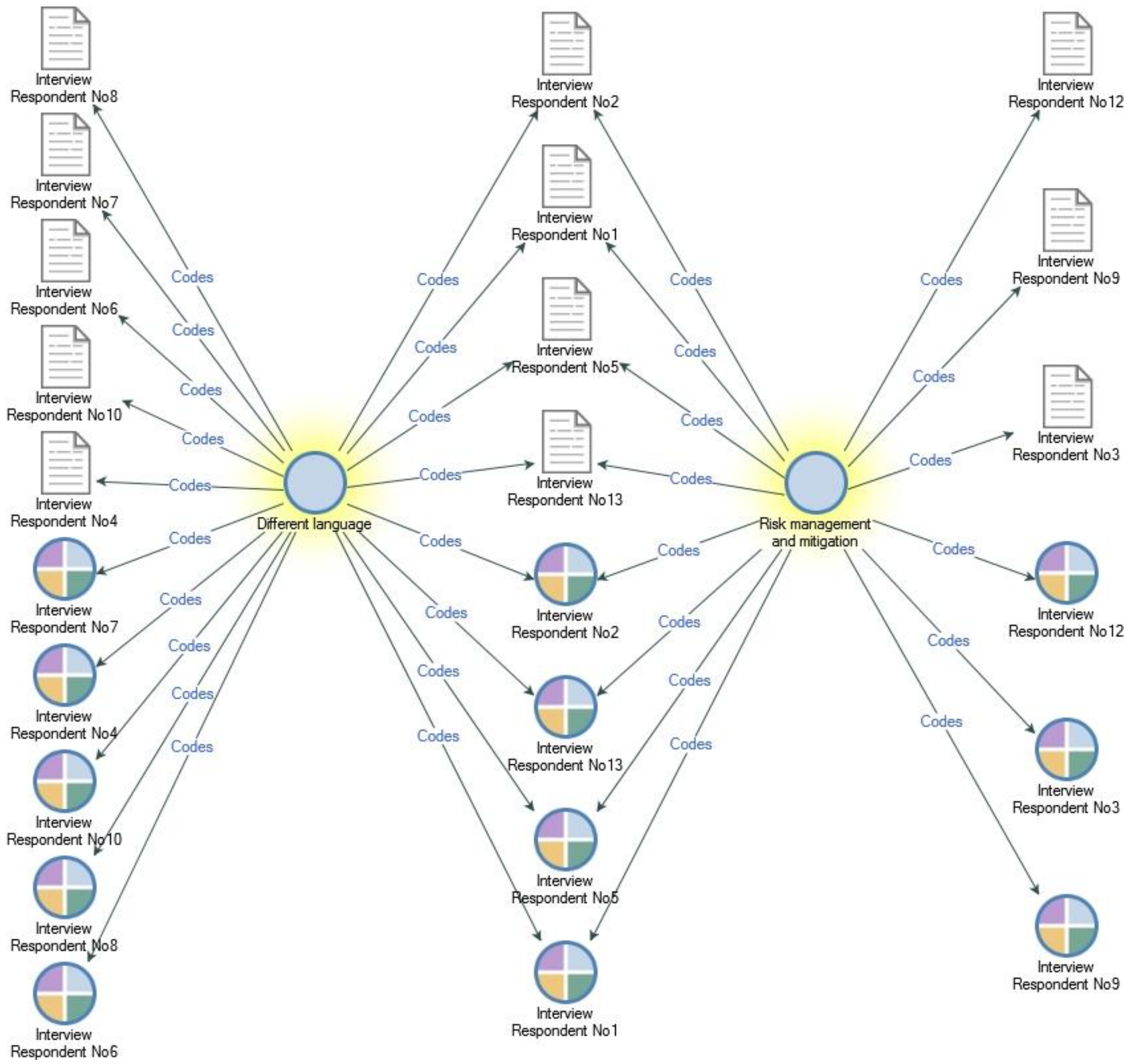


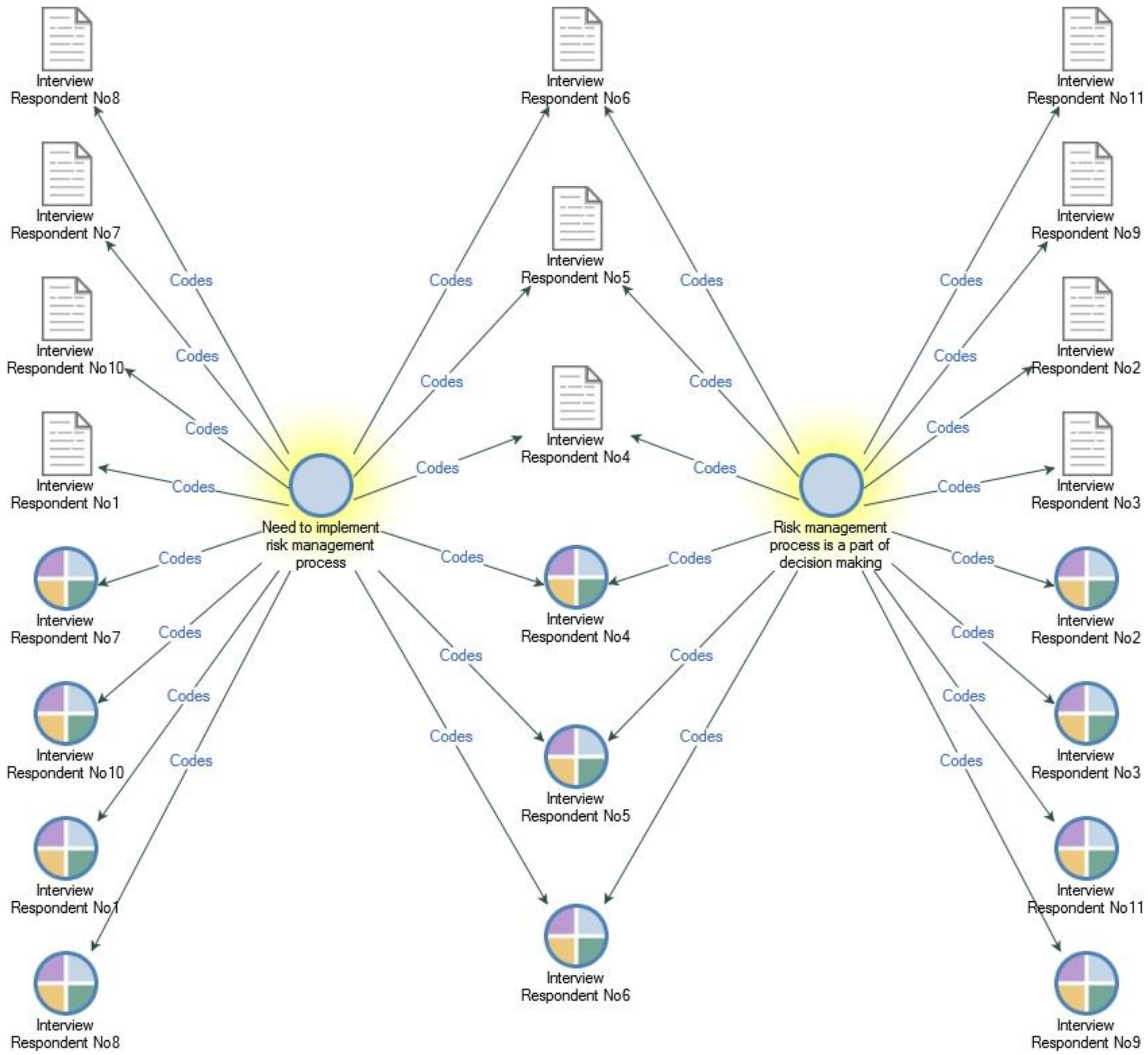
Interview Respondent No11
Interview Respondent No8
Interview Respondent No9
Interview Respondent No2
Interview Respondent No5
Interview Respondent No4
Interview Respondent No13
Interview Respondent No3
Interview Respondent No4
Interview Respondent No2
Interview Respondent No13
Interview Respondent No5
Interview Respondent No3
Interview Respondent No8
Interview Respondent No11
Interview Respondent No9
Communication risks
Interview Respondent No7
Interview Respondent No6
Interview Respondent No1
Interview Respondent No7
Interview Respondent No1
Interview Respondent No6
Contract preparation
Codes


Foreign exchange
Inflation
Interview Respondent No7
Interview Respondent No6
Interview Respondent No10
Interview Respondent No2
Interview Respondent No1
Interview Respondent No4
Interview Respondent No13
Interview Respondent No3
Interview Respondent No8
Interview Respondent No9
Codes



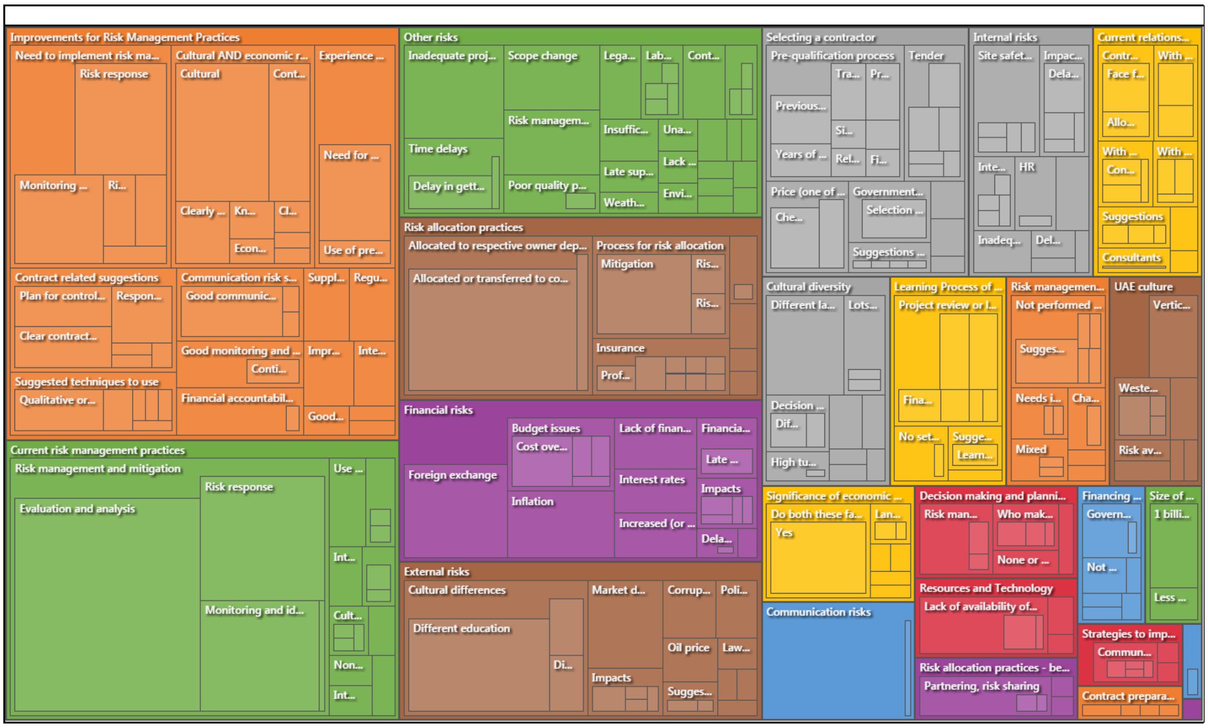
Interview Respondent No8
Interview Respondent No6
Interview Respondent No9
Interview Respondent No2
Interview Respondent No1
Interview Respondent No5
Interview Respondent No13
Interview Respondent No3
Interview Respondent No10
Interview Respondent No11
Interview Respondent No7
Interview Respondent No4
Codes
UAE culture
Communication risks
Interview Respondent No1
Interview Respondent No2
Interview Respondent No13
Interview Respondent No5
Interview Respondent No3
Interview Respondent No8
Interview Respondent No9
Interview Respondent No6
Interview Respondent No10
Interview Respondent No7
Interview Respondent No4
Interview Respondent No11

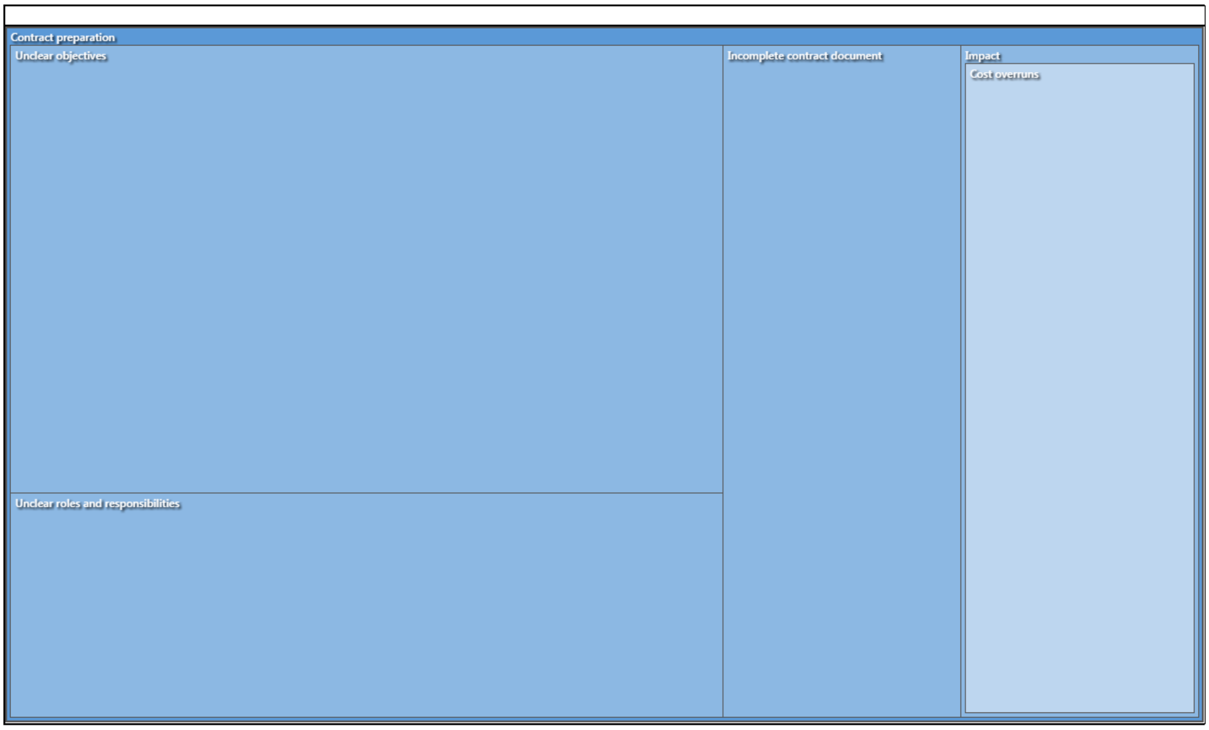

Interview Respondent No8
Interview Respondent No7
Interview Respondent No6
Interview Respondent No10
Interview Respondent No4
Interview Respondent No7
Interview Respondent No4
Interview Respondent No10
Interview Respondent No8
Interview Respondent No6
Different language
Interview Respondent No2
Interview Respondent No1
Interview Respondent No5
Interview Respondent No13
Interview Respondent No2
Interview Respondent No13
Interview Respondent No5
Interview Respondent No1
Risk management and mitigation
Interview Respondent No12
Interview Respondent No9
Interview Respondent No3
Interview Respondent No12
Interview Respondent No3
Interview Respondent No9
Codes

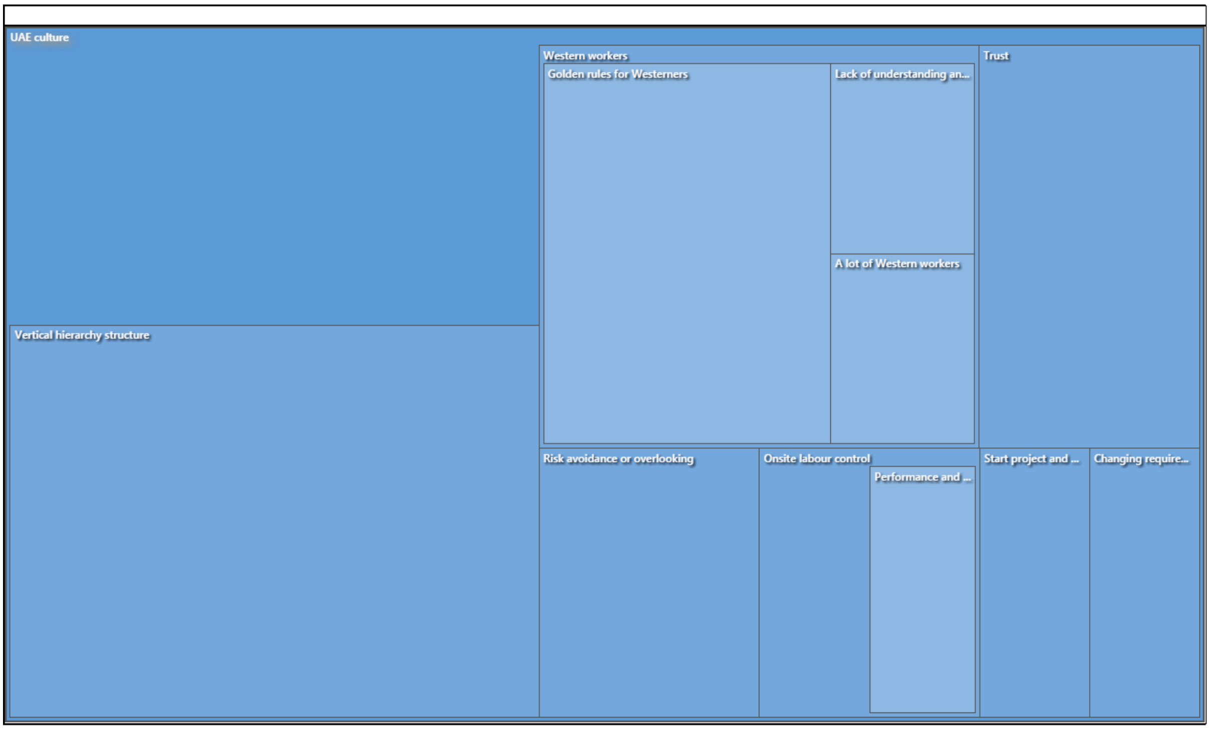


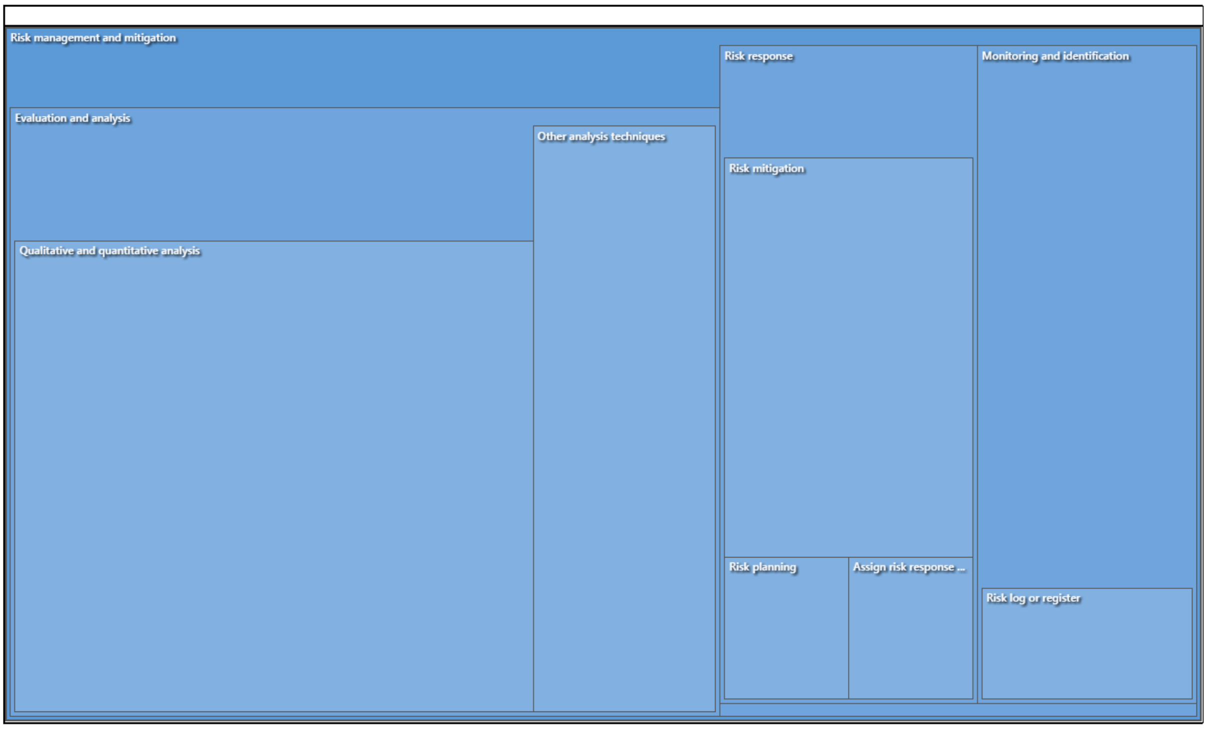
Interview
Respondent No8
Interview
Respondent No6
Interview
Respondent No11
Interview
Respondent No7
Interview
Respondent No9
Interview
Respondent No5
Interview
Respondent No10
Interview
Respondent No2
Interview
Respondent No4
Interview
Respondent No1
Interview
Respondent No3
Codes
Need to implement
risk management
process
Risk management
process is a part of
decision making
Interview
Respondent No7
Interview
Respondent No4
Interview
Respondent No2
Interview
Respondent No10
Interview
Respondent No3
Interview
Respondent No5
Interview
Respondent No1
Interview
Respondent No11
Interview
Respondent No6
Interview
Respondent No8
Interview
Respondent No9

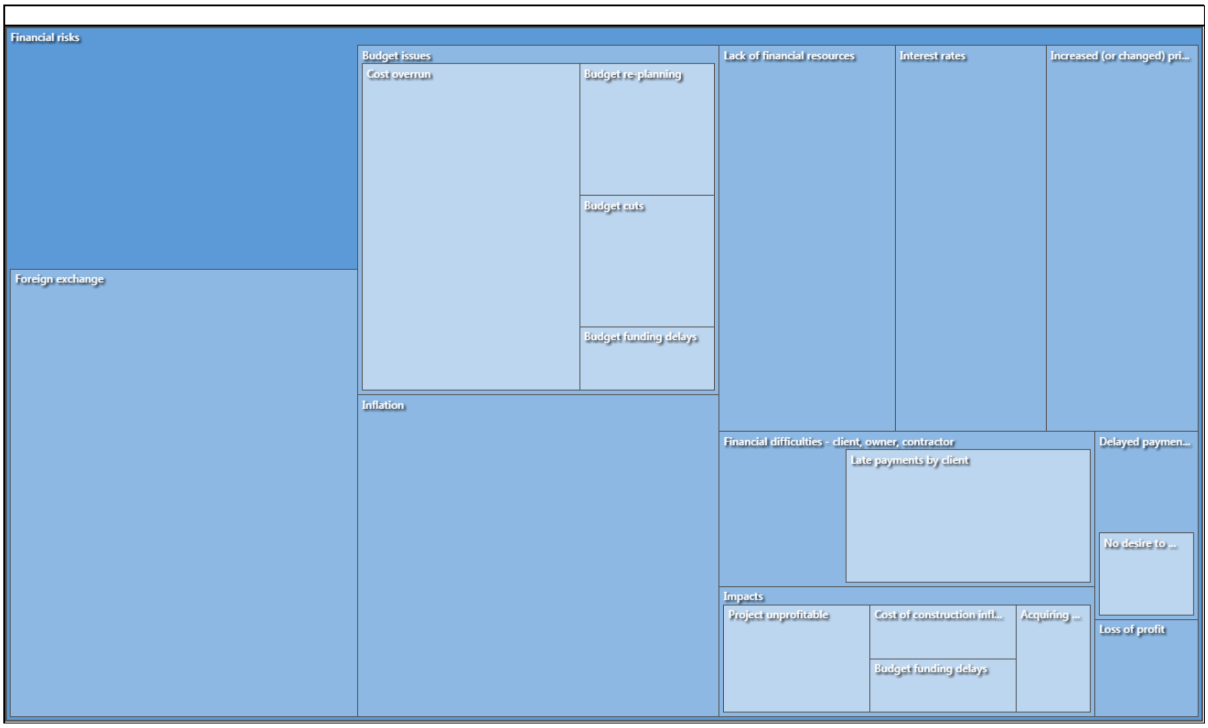
1.7 An Example of Nodes Compared by Number of Coded (Tree Map)



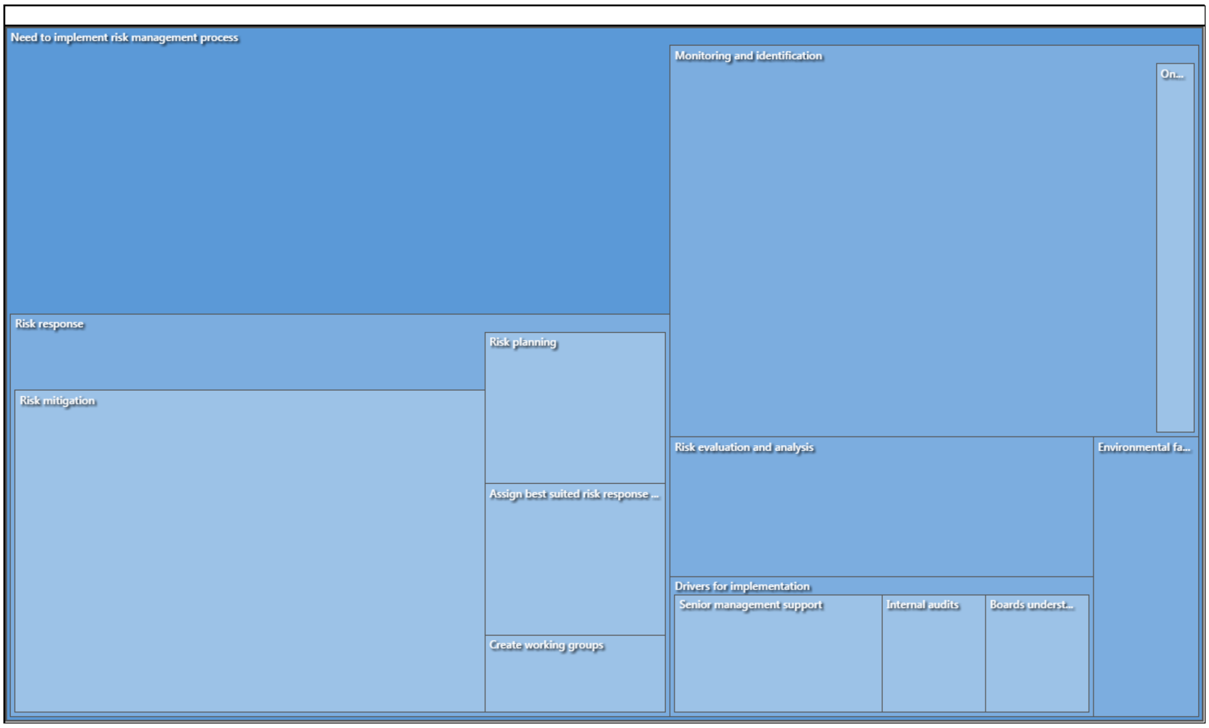



UAE culture
Western workers
Trust
Golden rules for Westerners
Lack of understanding an...
A lot of Western workers
Vertical hierarchy structure
Risk avoidance or overlooking
Onsite labour control
Performance and ...
Start project and ...
Changing require...


Risk management and mitigation
Risk response
Monitoring and identification
Evaluation and analysis
Other analysis techniques
Risk mitigation
Qualitative and quantitative analysis
Risk planning
Assign risk response ...
Risk log or register



Financial risks
Budget issues
Cost overrun
Budget re-planning
Budget cuts
Budget funding delays
Lack of financial resources
Interest rates
Increased (or changed) pri...
Foreign exchange
Inflation
Financial difficulties - client, owner, contractor
Late payments by client
Delayed paymen...
No desire to ...
Impacts
Project unprofitable
Cost of construction infl...
Acquiring ...
Budget funding delays
Loss of profit



Need to implement risk management process
Monitoring and identification
On...
Risk response
Risk planning
Risk mitigation
Assign best suited risk response ...
Create working groups
Risk evaluation and analysis
Environmental fa...
Drivers for implementation
Senior management support
Internal audits
Boards underst...

1.8 Nodes Clustered by Word Similarity